ANNALES MEDICINAE EXPERIMENTALIS ET BIOLOGIAE FENNIAE

SEASONAL VARIATIONS OF SERUM LIPIDS IN HEALTHY MEN

BY

JOUKO PALOHEIMO

VOL. 39 1961 SUPPLEMENTUM 8

MERCATORIN KIRJAPAINO
HELSINKI, FINLAND

FROM THE WIHURI RESEARCH INSTITUTE

SEASONAL VARIATIONS OF SERUM LIPIDS IN HEALTHY MEN

BY

JOUKO PALOHEIMO

HELSINKI 1961

Translated by Eva Palmgren

Vammala 1961, Vammalan Kirjapaino Oy.

ACKNOWLEDGEMENTS

The present study was carried out in 1958—1959 at the Wihuri Research Institute, Helsinki. The theme was suggested to me by Professor P. I. Halonen, M.D., Head of the Institute and Chief of the First Medical Clinic, University of Helsinki. I am very much indebted to Professor Halonen for the benefit I have derived from his experienced guidance and for valuable advice during the course of the work. I also wish to thank Professor Halonen for kindly placing the laboratory facilities of the Wihuri Research Institute at my disposal.

I express my sincere thanks to Aarne Konttinen, M.D., for expert advice concerning both the planning of the study and the methods of analysis.

My gratitude is due to Mr. Erik Gabrielsson, Chief of the Police Force in Helsinki, Mr. Valentin Soinne, Director General of the Prison Administration and Professor Sven Erkkilä, M.D., former Chief Medical Officer of the Prison Administration, who made it possible for me to perform this study on policemen and convicts. To the men who volunteered I extend my thanks for their interest.

I am indebted to Docent Martti J. Karvonen, Ph.D., for valuable suggestions concerning the preparation of the manuscript.

To Mr. Jaakko K. Kihlberg, M.Pol.Sci., I owe my thanks for the planning and performance of the statistical treatment of the results. Mrs. Aili Muroma, M.Pol.Sci., performed a part of the statistical analysis.

This study has been aided by a grant from the Finnish Cultural Foundation.

Helsinki, November 1961.

Jouko Paloheimo

CONTENTS

INTRODUCTION

The relationship between the serum lipids and the development of atherosclerosis has been the object of intensive research. The fact that there are large individual differences in serum lipid levels has prompted numerous investigators to analyse these differences with a view to elucidating the role of the serum lipids in the development of vascular changes. The work performed during the last ten years, in particular, has increased our knowledge concerning the normal serum lipid level, its variability and the factors causing fluctuations.

It has been generally believed that in a given individual the serum lipid level remains more or less constant. Lately it has been shown, however, that various external factors may bring about marked changes in the serum lipid level. Such factors are, for instance, dietary changes, various forms of stress, certain diseases and certain chemical substances.

Many environmental factors show seasonal variations. Hence, it seems reasonable to suggest that the succession of the seasons may be accompanied by periodic fluctuations in the serum lipid level. Particularly in a geographical region exhibiting marked climatic differences between winter and summer, the occurrence of seasonal changes seems possible.

INTRA-INDIVIDUAL VARIATIONS IN THE SERUM LIPID LEVEL

Numerous studies have been published on the variability of the serum lipid level in humans. The fluctuations occurring during one day and over periods of days, weeks, months and years have been recorded in order to determine the normal range of variation, which it is necessary to know when attempting to analyse the effect of a certain factor on the serum lipid level.

Many writers have come to the conclusion that no appreciable fluctuations in the serum cholesterol and phospholipid levels occur during the course of a day. Gardner and Gainsborough (1928) found that the results of earlier studies dealing with the variability of cholesterol values were conflicting. From their own observations they concluded that diurnal variations in serum cholesterol and phospholipids are slight, but nonetheless they recommended the collection of blood samples in the fasting state. Many later investigators (e.g. McClure and Huntsinger 1928, Bruger and Somach 1932, Boyd 1935, Sperry 1936, 1937, Turner and Steiner 1939, Brun 1940, Keys *et al.* 1950 a, 1955 b, Chandler *et al.* 1953, Shapiro *et al.* 1957, 1959, Segall and Neufeld 1960) have also noted only slight variations in the serum lipid values obtained during one day. The greatest diurnal variation in cholesterol observed by these writers was 12—13 per cent of the mean, the average being under 10 per cent. Shapiro *et al.* (1957, 1959) also found that »the spread of each individual's hourly values about his mean for the day was relatively narrow, 95 per cent were within 10 per cent of the mean». In their series the standard deviation of the individual cholesterol values was between 5 and 10 mg. per 100 ml., the standard deviation for the whole series being 7.7 mg. per 100 ml.

The fluctuations noted in the phospholipids have been of the same magnitude, i.e. under 10 per cent of the mean (e.g.

McClure and Huntsinger 1928, Boyd 1935), and the same holds good in regard to ester cholesterol (e.g. Boyd 1935, Josephson and Dahlberg 1952).

Keys *et al.* (1950 a, 1955 b) found that the »non-basal» cholesterol values exceeded the »basal», i.e. fasting, values by 3.8 mg. per 100 ml. (1.9 per cent). They also found that after a meal the change in cholesterol level was dependent on whether the subjects worked or rested, but the difference was so small that, according to the writers, »it may be neglected in most comparative studies». In a study on the level of lipoproteins (determined by ultracentrifugation), cholesterol and phospholipid, Chandler *et al.* (1953) observed a significant diurnal variation only in the lipoprotein fraction Sf 20—100. They pointed out, however, that »although the diurnal variation for most individuals or for a group may not exceed the standard errors of measurement, it may exceed it for some persons, especially those with elevated levels».

It has been found, then, in many studies that the time of sample taking, diet and the amount of daily work and rest do not significantly influence the serum cholesterol and phospholipid levels.

In contrast to the investigators cited above, McEachern and Gilmour (1932 a) noted marked changes in the cholesterol values of 28 subjects in five hours, the range being from 25 to 195 mg. per 100 ml. and the mean difference between the highest and the lowest values being 40 mg. per 100 ml. Morrison (1952) observed a difference of 16—18 mg. per 100 ml. in the cholesterol values after meals, while the phospholipid values showed changes of 47—93 mg. per 100 ml. In patients with coronary artery disease the corresponding change in cholesterol was as high as 69 mg. per 100 ml. and the change in phospholipids amounted to 70 mg. per 100 ml. An interesting study was performed by Peterson *et al.* (1960) on 10 subjects whose cholesterol levels had been previously determined by the same writers. In five of these, marked variation had been observed in samples drawn at various intervals, whilst in the remainder the cholesterol values had been fairly stable. During a »control» day the standard deviation of the cholesterol values was from 5 to 28 mg. per 100 ml. in those subjects whose values had

previously shown wide variations, whilst in the group of subjects with relatively constant cholesterol levels the standard deviation was from 8 to 11 mg. per 100 ml. Under mental stress and excitement particularly marked diurnal variations were observed, the standard deviation of the cholesterol values being from 25 to 33 mg. per 100 ml. in the former group and from 12 to 16 mg. per 100 ml. in the latter group during the test period of five days.

A number of writers have observed only slight changes, under 20 mg. per 100 ml., in serum cholesterol during a period of some days (e.g. Keys *et al.* 1959), but Morrison (1952) reported changes ranging from 6 to as much as 50 mg. per 100 ml. In samples drawn at one-week intervals Jones *et al.* (1951) observed a variation of 22 mg. per 100 ml. and Perkins *et al.* (1958) a variation of as much as 56—59 mg. per 100 ml. Jones *et al.* (1951) also studied the variation in the lipoprotein fraction Sf 12—20, which they found to be 10 mg. per 100 ml.

The majority of studies on variability of the cholesterol level deal with the fluctuations occurring through periods of some months or a year. Luden (1917) determined his own cholesterol level for seven months, finding it to be fairly constant. In different papers the range of variation of the cholesterol level has been from 4 to 27 per cent (e.g. Turner and Steiner 1939, Gordon and Brock 1958, Thompson *et al.* 1959), and expressed in mg. per 100 ml., from 5 to 24 mg. per 100 ml. (Man and Gildea 1936). A variation of as much as 125 mg. per 100 ml. was reported by Friedman *et al.* (1958).

Schube (1936) reported individual differences between 19 and 73 mg. per 100 ml. in the range of variation of cholesterol values. Morrison *et al.* (1949), Josephson and Dahlberg (1952) and Watkin *et al.* (1954) observed deviations of about 10—13 mg. per 100 ml. from the mean level of cholesterol. In 30 subjects studied by Gordon and Brock (1958) the intra-individual range was from 26 to 96 mg. per 100 ml., the average for the group being 45 mg. per 100 ml. This implies a standard deviation of the mean of 7—27 mg. per 100 ml. A similar range was noted by Thomas and Eisenberg (1959), who regarded a standard deviation of 25 mg. per 100 ml. as the upper limit for the normal

variation in cholesterol. In a series studied by Thompson *et al.* (1959) one-third showed a variation exceeding 40 mg. per 100 ml. In a series of convicts studied by Thomas *et al.* (1961) the individual standard deviations during one year ranged between 10 and 49 mg. per 100 ml., and the differences between the highest and the lowest values noted in these subjects ranged between 38 and 150 mg. per 100 ml.

The variations in cholesterol level observed over periods of several years (e.g. Pucher *et al.* 1934, Man and Gildea 1937, Sperry 1937, Peters and Man 1943, Steiner and Domanski 1943, Sperry and Webb 1950, Man and Peters 1953, Paterson and Derrick 1957, Thomas and Eisenberg 1957, Milch *et al.* 1958, Groover *et al.* 1960) have been of the same magnitude as the variations noted during shorter periods, which have been discussed in the foregoing. Expressed in per cent, the variations in cholesterol have ranged between 1 and 31 per cent of the mean (e.g. Man and Gildea 1937). In Sperry's (1937) series, 17 subjects out of 25 exhibited a variation of less than 6 per cent of the mean value, whilst the maximum variation was 12 per cent. Paterson and Derrick (1957) noted a variation of 11 per cent during a period of four years.

Peters and Man (1943) reported individual variations in the level of cholesterol ranging between 1 and 68 mg. per 100 ml. of the mean during a period of four years. In a study by Man and Gildea (1937) the maximum variation was 66 mg. per 100 ml. Thomas and Eisenberg (1957) and Groover *et al.* (1960) regarded a deviation of 25 mg. per 100 ml. from the mean value as normal. In the last-mentioned paper a variation of over 50 mg. per 100 ml. was reported in 37 subjects out of 117.

Sperry and Webb (1950) and Man and Peters (1953) performed repeated cholesterol determinations in subjects they had studied 10 to 20 years before. In Sperry and Webb's series of 22 subjects the cholesterol values had remained more or less unchanged in 9 cases, whilst 12 subjects exhibited an increase of 15—30 per cent of the previous values. In Man and Peters' series of 16 subjects a rise was somewhat more frequent than a drop, the standard deviation of the cholesterol values being 20 mg. per 100 ml., at most.

In the following list are compiled the results of some of the above-mentioned studies concerning the intra-individual variability of total cholesterol.

Authors	No. of Subjects	Observation Time	No. of Determinations	Variation of Total Cholesterol Level in mg%	in SD	in Per Cent of the Mean
Sperry 1937	25	2 yrs. 4 mo.	2—10	12		
Steiner and Domanski 1943	15	3 mo.— 1 year 2 mo.	7—42		8.7 (range 3—17)	
Peters and Man 1943	17	2 weeks— 5 yrs.	2—34	1—68		
Morrison 1952	5	2—7 days	2—5	6—50		
Thomas and Eisenberg 1957	49	1 year— 1 year 10 mo.	3 or more			maximum 29 %
Gordon and Brock 1958	30	4 mo.	6—18	45	14.7 (range 7—29)	6—22
Thomas and Eisenberg 1959	11	2 mo.— 8 mo.	54—68		10.8— 27.4	
Groover et al. 1960	117	5 yrs.	6 or more	36		
Thomas et al. 1961	25	1 year	12	38— 150	10.8— 49.6	

Irrespective of the length of the test period, greater fluctuations have been observed in subjects with high cholesterol values than in those showing low cholesterol values (e.g. Chandler *et al.* 1953, Watkin *et al.* 1954, Thomas and Eisenberg 1957, Peterson *et al.* 1960). There is consensus of opinion that repeated determinations at fixed intervals are required for the determination of individual cholesterol levels (e.g. Thompson *et al.* 1959, Groover *et al.* 1960, Segall and Neufeld 1960).

In patients with coronary lesions wider variations in cholesterol have been observed than in healthy subjects (e.g. Steiner and Domanski 1943, Astrup 1948, Hammarsten *et al.* 1957, Levere *et al.* 1958, Rivin *et al.* 1958, Rosenman and Friedman 1960, Segall and Neufeld 1960). In Astrup's (1948) series of 79 patients fifty per cent had cholesterol values showing a variation of over 50 mg. per 100 ml. from the mean value. In the patients studied by Hammarsten *et al.* (1957) the average intra-individual range was 103 mg. per 100 ml. In the series of Rivin *et al.* (1958) the standard deviation of the cholesterol values was 30 mg. per 100 ml., and Levere *et al.* (1958) reported variations of 33—39 per cent of the mean values. The changes were »non-periodic, cyclic and unpredictable». Segall and Neufeld (1960) studied the lipid values in 10 subjects for four years at intervals of some weeks. All these subjects had high cholesterol levels and coronary disease. The average variation was 27.7 per cent of the mean during two-week periods, 32.2 per cent during four-week periods and 44.4 per cent during one year. In one of the subjects the variation during one year was only 16 per cent of the mean, in another it was 95 per cent.

In long-term studies the increasing age of the subjects has to be considered in the evaluation of the results. It has been shown that the serum cholesterol and phospholipid levels rise with age (e.g. Keys *et al.* 1950 b, c, Gertler *et al.* 1950 b, Jones *et al.* 1951, Keys 1952, Nikkilä 1955, Adlersberg *et. al.* 1956, Thomas and Eisenberg 1957, Keys *et al.* 1958, Schaefer *et al.* 1958 a, b, 1960, Corsi *et al.* 1959, Carlson 1960) and begin to fall again in men at the age of about 55—60 years, while in women they continue to rise after this age (e.g. Keys *et al.* 1950 b, c, Keys 1952, Nikkilä 1955, Nikkilä and Niemi 1957). A change in the lipid values with age cannot be regarded as the rule, however. According to Thomas and Eisenberg (1957), »the effect of aging on the cholesterol level is best recognized as a large group phenomenon and there is no predicting what an individual's pattern will be».

Summarizing the data on the variability of the serum lipids, Page's (1960) summary of certain studies on cholesterol may be cited. He says, among other things, that »the thing that has

become increasingly apparent is that you cannot lump all people together according to the variability of their cholesterol. Most people who have had enough experience would agree that there are some so-called normal people who have wide swings in their cholesterols, others who exhibit extraordinary stability».

Although the literature on the serum lipids in humans is very extensive, only a few writers have approached this question from the standpoint of seasonal variations, and the studies in which this possibility has been taken into account are mostly based on short series and scanty analyses.

Some writers have observed seasonal variations in the blood lipid values. Currie (1924), for instance, who studied both normal subjects and cancer patients at Glasgow, Scotland, found that the cholesterol values were highest in summer. Similar observations were made by Pucher *et al.* (1934) at Buffalo, USA, and Villaverde (1939) at Cuba. Pucher *et al.* drew attention to the fact that they had noted a transient fall in cholesterol in the spring. At Rochester, N.Y., USA, Kaiser and Gray (1934) observed that during the cold season the serum lipid values were higher than during the warm summer in both healthy children and children suffering from various diseases. He stated, however, that »seasonal variations are suggestive though not conclusive». In a study carried out on Finnish men Keys *et al.* (1958) noticed marked seasonal variations in the serum cholesterol values. In eastern Finland the level rose from June to the end of January by about 100 mg. per 100 ml. The writers stated that »seasonal variations should be considered at least in regions such as East Finland, where seasonal differences in climate and mode of life are extreme».

In contrast to the above-mentioned studies, in which seasonal variations in the serum lipid values were observed, certain writers have failed to detect periodical changes accompanying the succession of the seasons. McEachern and Gilmour (1932 b), who performed their studies at Winnipeg, USA, observed no seasonal variations in serum cholesterol. Man and Gildea (1937), of New Haven, USA, noted no such variations in the values for serum cholesterol, phosphatides and fatty acids, and Turner and Steiner (1939) also failed to notice seasonal variations in the

cholesterol levels of hospital patients in New York, USA. The Swedes Josephson (1947) and Josephson and Dahlberg (1952) determined the cholesterol levels of certain subjects in the spring and in the autumn without detecting any significant differences. In Finland, Konttinen (1959) found that the mean values for serum cholesterol were the same in groups of young men called up for compulsory military service in February, June and October, respectively. This finding he regarded as evidence against the occurrence of seasonal variations. Härtel and Aro (in process) performed monthly serum cholesterol determinations on 12 men at Spitzbergen. In these very exceptional conditions no changes which could be related to the succession of the seasons were detectable.

When the present paper was in process, Thomas *et al.* (1961) published a study on seasonal variations in the serum cholesterol levels of 25 young convicts (aged 22—28 years). At Baltimore, USA, they determined the serum cholesterol once a month from December, 1958, to November, 1959, noting clear seasonal variations, the values being highest in the winter months and lowest in late spring, summer and early autumn. In a group of 16 convicts in which determinations were made every month the mean values for cholesterol were 260—265 mg. per 100 ml. in December, January and the following November against 214.5 mg. per 100 ml. in May and 216.5 mg. per 100 ml. in June.

As appears in the foregoing, the serum lipid level varies greatly in some subjects, whilst in others only slight changes occur. The data available on the occurrence of seasonal variations in serum lipid are scanty. In long-term studies the possible presence of such variations may, however, significantly influence the results. For this reason it was regarded as justified to study the question of whether periodical changes related to the succession of the seasons are observable in the serum lipid values. In Finland where there is a clear difference in climate between the summer and the winter, conditions seem to be favourable for the performance of such a study.

MATERIAL AND PLAN OF INVESTIGATION

The study was made on a series of 80 men, viz. 45 policemen and 35 convicts. At the beginning of the study the median age of the policemen was 33.2 years (25—45 years) and that of the convicts 32.7 years (23—49 years).

The series was chosen with a view to studying two groups of subjects living under conditions which were, first, known as exactly as possible, and, second, markedly different from one another. It was concluded that policemen and convicts fulfilled these requirements. The former are mainly employed outdoors, and their work remains the same throughout the time of a study. Convicts almost invariably work indoors. Policemen represent the normal, inasmuch as their diet is unrestricted and they can spend their free time as they like, whilst the activities of convicts are controlled even during their leisure.

The series consisted of healthy men under the age of 50, who volunteered for the study. Initially the total number was 91, but during the course of the study 11 men had to be excluded owing to illness or accident.

Data regarding the state of health of the men to be studied were collected by questioning them themselves and from the health authorities. (Both the police force and the prison have their own doctors. A miniature x-ray picture is taken every year.) In addition, a careful physical examination formed part of the study, and any changes in the state of health of the men were noted throughout this period.

The Policemen. — All the policemen were employed by the police department of the city of Helsinki. They work by 12-hour shifts, every sixth day is free. In both the night and the day shifts there are 3- to 4-hour spells of watch-duty.

Of the policemen 4 were sergeants. Their work consists mainly of inspections and being on call, and they work both

indoors and outdoors. Twenty were traffic policemen, who mainly work outdoors, doing inspection work, watch-duty and traffic control. Eleven men were members of the mounted police and 10 were radio policemen, who make their rounds by car. The work of a policeman implies no heavy physical strain, although night shifts and temporary additional tasks increase the stress.

Policemen are bound to participate in athletics and sports and in annual contests. In their free time, too, many of them go in for athletics. Of the present series 9 men were active sportsmen. In addition to their principal jobs many of the present subjects worked as caretakers of blocks of flats.

Thirty-five of the policemen were married and, except for meals taken during working hours, were fed at home. The unmarried men ate at restaurants. When the group were questioned regarding their diet, this was found to consist of ordinary Finnish food. No one was on a special diet. No further attention was paid to this point, since it was obvious that the diet of the policemen in no way differed from the ordinary Finnish diet.

In regard to alcohol consumption, it appeared that the policemen took alcohol only occasionally. Thirty-three men were smokers, and none of these smoked more than 20 American-type cigarettes a day.

The Convicts. — The subjects of this group were all convicts from the Helsinki Central Prison. Before the beginning of this study they had been imprisoned for at least a year, the majority for three to five years, and one man for 12 years. Hence, it may be taken for granted that they were accustomed to prison life when the study was commenced.

The convicts worked mainly in a printing-house, a bakery, a painter's workshop and a metal-worker's workshop. Only one of the present subjects was engaged in outdoor work throughout the period under review, as a van-driver's assistant or in building, whilst three men were employed on road-construction work for half the period of the study. They had eight-hour working days. The evenings were spent in club activities or reading, or to some extent at ball-games. Furthermore, educational work was carried out among them.

The convicts were given a fixed diet, in which the same dishes recurred at intervals of two to three weeks. The diet was the same from February 1958, when the study was commenced, to the end of September 1958, when minor changes were introduced.

Throughout the study the total calorie value of the diet was about 3100 calories a day. The amount of protein was 110 g. The diet contained fat to about 20 per cent of the caloric intake. The total daily intake of carbohydrates amounted to about 550 g.

When the diet was changed in October 1958, the total calorie value remained the same, but the proportion of calories in the so-called basic diet, which did not include bread, was increased. The contribution of fat to the total caloric intake rose to 22.5 per cent. This was mainly due to an increased supply of milk and meat.

The amount of vitamins and minerals in the diet remained the same and sufficient, but the supply of vitamin A was doubled, from 1300 to 2500 i.u.

In addition to receiving the above-mentioned food, the convicts were allowed to buy a small amount of foodstuffs. The amounts remained more or less the same from month to month. On average, the convicts bought 0.40 kg butter or margarine, 1.2 kg sugar and 0.2 kg tinned meat a month.

One of the convicts said that he did not eat fat. Thirty-three were smokers, and these smoked Finnish-type cigarettes, which contain about 0.45 g tobacco, whilst American-type cigarettes contain about 1.2 g. The number of these cigarettes smoked daily varied between 10 and 50, which in amount of tobacco corresponds to a consumption of less than 20 American-type cigarettes.

Before imprisonment many of the convicts had from time to time been excessive drinkers, but as convicts they had no opportunity to obtain alcohol.

Many of both the convicts and the policemen were regular blood donors, but during the time of the study their services were not called for.

Plan of Study. — The study was performed in Helsinki from February 1958 to January 1959.

As precisely as possible at monthly intervals blood samples were drawn for lipid analysis. Simultaneously samples were collected for the determination of haemoglobin and the erythrocyte sedimentation rate.

Once a month the subjects were weighed, and at the end of the study measurements were made in order to assess body build and nutritional state. Furthermore, during the course of the study a careful physical examination was made.

The physical examination included auscultation of the heart and lungs and palpation of the abdomen, particular attention being paid to the size of the liver. The thyroid gland was carefully palpated, and possible signs of thyrotoxicosis and hypothyroidism were noted. The blood pressure was measured in the sitting position, when the subjects had been seated for 30—60 minutes, by the indirect Riva-Rocci method, using a mercury blood-pressure meter. A blood pressure of under 150/90 was regarded as normal.

Every time when samples were collected the subjects were questioned regarding their state of health, any changes in their working or living conditions and the occurrence of any relevant events in the interval.

The Collection of Samples. — All blood samples were drawn from the cubital vein using stasis of as short a duration as possible.

For lipid determination about 15 ml of blood was drawn and left to coagulate. Simultaneously samples were drawn for the determination of the erythrocyte sedimentation rate and haemoglobin.

After about three hours, the coagulated blood sample was centrifuged and the clear serum used for lipid determination.

In the group of policemen blood was drawn between 10 and 12 a.m. after fasting for six to eight hours. Then some of the men had been working for some hours, others had just come on duty and still others had finished their working day.

In the group of convicts samples were collected between 6 and 8 a.m., immediately after waking, when the subjects had been fasting for at least ten hours.

METHODS

ANALYTICAL METHODS

Serum total cholesterol and total phospholipids and the cholesterol of the electrophoretically isolated α- and β-lipoproteins were determined. In addition, haemoglobin and the erythrocyte sedimentation rate were measured.

The serum total cholesterol was determined by the modification of the method of Abell *et al.* (1952) introduced by Anderson and Keys (1956), modified by Konttinen (1959). On the day on which the sample was drawn, 0.1 ml of serum was sucked onto a piece of Whatman no. 1 filter paper and dried. The cholesterol analyses were made two weeks later. After hydrolysis and petroleum-ether extraction Lieberman—Burchard's reagent was added and the staining reaction was read with a Beckman B photometer at wavelength 625 mμ 35 minutes after addition of the reagent.

The amount of total serum phospholipids was determined by analysis of the lipid phosphorus, and using the coefficient 25.0 the phosphorus value was converted to phospholipids. After burning a serum ethanol-ether extract, lipid phosphorus was determined by Fiske-Subbarow's method (1925) as described by Nikkilä (1953). The analysis was always begun on the day when the sample was drawn. Optical density was measured with a Beckman B photometer using 5 cm cuvettes at wavelength 660 mμ.

For the determination of the amount of cholesterol in the lipoprotein fractions the serum lipoproteins were separated by paper electrophoresis into two main fractions. They were separated by cutting, and the cholesterol was determined in the same way as total cholesterol. Paper electrophoresis was performed by a method elaborated by Nikkilä (1953) and modified by Konttinen (1959). Onto a piece of Whatman no. 1 filter paper measuring 12 $\times$ 30 cm about 0.15 ml of serum was pipetted. Running was performed for 3—4 hours in a barbiturate

buffer of pH 8.6. When the paper had dried, a 2.5 cm broad slip was cut from its margin and the lipids were stained as suggested by Swahn (1953). The two lipid fractions were then cut apart (Miettinen 1956), and the amount of cholesterol was measured. Using these relative values and the value for total cholesterol, the amount of cholesterol in the α- and β-fractions was calculated.

The erythrocyte sedimentation rate and haemoglobin were determined by the routine methods employed in the laboratory. The former was determined by Westergren's technique as a one-hour value. For haemoglobin determination 0.025 ml of blood was drawn into 10 ml of 0.04 per cent ammonia water and the colour was read with a Hilger spectrophotometer and filter no. 55. The values were obtained from the standard table of the laboratory, indicated as grams per 100 ml.

BODY MEASUREMENTS

The subjects were weighed once a month on the same balance. They were weighed with their clothes on, but without shoes, and the weight was reduced by the weight of the clothes, which had previously been determined. The readings were accurate to the nearest 0.5 kg. The relative body weight was determined according to the mean values in the tables of the Metropolitan Life Insurance Company (1943).

Height was determined to the nearest centimetre.

The thickness of the adipose tissue was measured with a caliper from the upper arm skinfold over the triceps muscle and from the subscapular skinfold (Brožek 1956). The measurements were made at 0.5 mm accuracy. The results are indicated as the sum of the thickness of the skinfolds. Biacromial and bicristal diameters were measured with an anthropometer at 1.0 mm accuracy.

STATISTICAL TREATMENT

Seasonal Variations. — To describe statistically distributions of observed values in each group studied in each month, cumulated per cent distributions have been utilized. Such a distribution curve rises monotonously from zero at the lowest observed value to 100 per cent at the highest observed value.

The curves have been graphed, and from the graphs the three quartiles Q_1, Q_2 and Q_3 have been determined. Plotting the quartiles as a function of time, a description of shift of the distributions in time obtains. In particular, the second quartile Q_2 then describes the development of the central tendency, and has been used for further calculations as described in what follows. As measure of dispersion, the semi-interquartile range has been determined, defined by $\frac{1}{2}(Q_3—Q_1)$. This quantity is approximately two-thirds of the standard deviation of the distribution.

Graphs have also been prepared to illustrate shift of the distributions in another way: to show the proportion of the material between some two arbitrary selected values as a function of time.

In preparation of per cent distributions, some missing values from the original framework of data were to be replaced. This was done by calculating linearly interpolated value (or values) for a subject between those months where the gap was. In the average, the proportion of missing values is about 5 per cent of the total number of entries, and seems to be rather haphazardly distributed in time, except for some concentration on the usual vacation times of the policemen. There is no reason to suspect that the procedure of replacements affects the analysis in any way.

To elucidate the pattern of possible systematic seasonal variation, two attempts have been made to utilize the medians mentioned above. In one attempt, moving averages were calculated including three consecutive months in each average, and tying up the beginning and the end of the observed year so as to obtain an uninterrupted cycle. Cyclic patterns thus obtained were tabulated and presented graphically.

Instead of moving averages, a perhaps more elegant and more general method is to assume some kind of mathematical model which in general terms would describe cyclic variation and for which the necessary parameters will be estimated from the set of original data. For such a model, innumerable possibilies exist; in the present study, trigonometric cyclic functions have been used. The equations used are of the type

$$Y = y + b_1 \sin O + b_2 \cos O,$$

where

Y = predicted seasonal value (for a given month)
y = mean of the medians of the same month
O = angle corresponding to the month (Feb. 30°, March 60° etc.)
b_1 and b_2 = regression coefficients.

In solving these equations, the usual method of least squares has been used. The results are shown in a tabulation of the estimated parameters, analysis of variance, and actual calculation of predicted values for each month which also are included in the graphs. The residual standard deviation shown indicates the variability of actual medians around the predicted or calculated curve. The probability value P shown indicates the significance of the observed correlation; small P (0.05 or smaller) characterizes good agreement between actual medians and the calculated values. (Table 1.)

TABLE 1

Regression Constants, Probability and Residual Standard Deviation.

Variable		Regression Constants y	b_1	b_2	Probability P	Residual Standard Deviation	Unit of Measurement
Total phospholipids	Convicts	221.1	—.0236	.0924	.1	9.8	mg%
	Policemen	235.1	.0241	—.0093	.1	6.0	
Total cholesterol	Convicts	206.4	—.1025	.0909	.025	8.6	mg%
	Policemen	216.0	—.0211	.0279	.1	5.9	
α-Cholesterol	Convicts	23.3	.1500	—.0914	.005	.9	%
	Policemen	23.1	.0333	—.0499	.1	.8	
β-Cholesterol	Convicts	157.8	—.1067	.0975	.005	5.7	mg%
	Policemen	167.3	.0146	.0366	.1	7.2	

(In regr. calculations sinO and cosO have been multipled by 100.)

Every mathematical model has its limitations. As for the present one, these comments can be made. The model implies that there be a single cycle per year with a distance of six months between maximum and minimum, the latter two quantities being at equal amplitude distance from the average level of the year. Location in time of the maximum can be anywhere along the year. This type of a model is known to fit with many

natural phenomena, one reason to which might well be the effect of the Earth's almost circular motion around the Sun.

Methodical Error. — The error of the method in certain determinations has been calculated by using independent duplications (not parallel determinations).

The following methodical errors were found in the various lipid determinations:

	n	s
Total cholesterol	40	4.0 mg%
Total phospholipids	100	2.12 mg%
α-Cholesterol	100	1.19 mg%
α-Proportion	100	0.55 per cent

Comparison of the Groups. — The means and standard errors of the mean were calculated by the usual methods. To determine the statistical significance of the differences between the groups, the t-test or analysis of variance were applied. The degree of statistical significance is expressed as P. P 0.001 designates a highly significant difference between the examined groups, P 0.01 a significant difference and P 0.05 an almost significant difference, and the P value indicated by two dots (..) means that the difference could not be ascribed any statistical significance.

Some Expressions Used in Reporting the Results. — Cumulative per cent distribution: cumulative per cent distribution rises from zero at the lowest value to 100 per cent at the highest observed value.

Q_1: the first quartile, with 25 per cent of the series

Q_2: the second quartile or median, dividing the series into two equal groups.

Q_3: the third quartile, with 75 per cent of the series.

D: semi-interquartile range = $\frac{1}{2}$ (Q_3—Q_1). D is approximately two-thirds of the standard deviation of the distribution.

A: moving average, i.e. the mean value for the values of three successive months.

C: predicted seasonal value, determined by statistical treatment.

RESULTS

BODY MEASUREMENTS

Table 2, and Table 12 in the Appendix, show the median values for height, weight, relative body weight, upper arm and subscapular skinfold sum and biacromial and bicristal diameters in the groups of policemen and convicts.

The cumulative per cent distribution of the values in question is shown in Table 13 in the Appendix.

The policemen were of sturdier build, on average, and they were heavier. In the group of policemen the median height was 180 cm, which is 7 cm more than the corresponding value, i.e. 173 cm, in the group of convicts. On average, the policemen weighed 11 kg more than the convicts, the median values being 78 and 67 kg, respectively.

In the group of policemen relative body weight and upper arm and subscapular skinfold sum were larger than in the group of convicts. The median values for relative body weight were 1.06 in the former and 0.98 in the latter. The upper arm and subscapular skinfold sum was 24 mm in the group of policemen against 17 mm (median values) in the group of convicts. Skeletal measures, too, were larger in the group of policemen. In this group the median biacromial diameter was 39.5 cm, which was 1.6 cm more than in the group of convicts, and the median bicristal diameter was 29.8 cm, which exceeded the corresponding value in the group of convicts by 0.9 cm.

TABLE 2

Height, Weight, Relative Body Weight, Arm and Subscapular Skinfold Sum, Biacromial Diameter and Bicristal Diameter: Median Values

	Height (cm)	Weight (kg)	Relative Body Weight	Skinfold Sum (mm)	Biacromial Diameter (cm)	Bicristal Diameter (cm)
Policemen	180	78	1.06	24	39.5	29.8
Convicts	173	67	0.98	17	37.9	28.9

THE SERUM LIPID LEVELS

The amount of total phospholipids, total cholesterol, α- and β-cholesterol and α- cholesterol expressed in per cent of total cholesterol were determined once a month. On the basis of these results the mean lipid levels were calculated for the two groups of subjects. The mean values are shown in Table 3.

TABLE 3

Mean Values and Standard Errors of the Mean for Serum Lipids. Statistical Significance of the Differences between the Groups: t-Test

	Policemen	Convicts	Difference between the Means	t	P
Total phospholipid mg%	240.2 ± 5.26	226.1 ± 4.41	14.1	2.06	0.05
Total cholesterol mg%	224.1 ± 6.67	211.8 ± 6.31	12.3	3.42	0.01
α-Cholesterol mg%	49.9 ± 1.14	48.1 ± 1.19	1.7	1.08	..
β-Cholesterol mg%	174.9 ± 6.87	163.3 ± 6.26	11.5	1.24	..
α-Cholesterol %	23.3 ± 0.99	23.6 ± 0.90	0.26	0.19	..

On comparing these mean values it is found that the mean value for total phospholipids was 14.1 mg. per 100 ml. higher in the group of policemen. The difference is almost significant (P 0.05). The mean total cholesterol value was 12.3 mg. per 100 ml. higher in the group of policemen, which makes a significant difference (P 0.01). By contrast, there were no significant differences between the two groups in regard to the mean values for α-cholesterol, β-cholesterol and α-cholesterol in per cent of total cholesterol.

THE CHANGES IN THE SERUM LIPID VALUES

The monthly median lipid values in the groups of policemen and convicts were statistically treated, the predicted seasonal value being determined, and the moving average being calculated for each month. The results are shown in Tables 14—18 in the Appendix. The median lipid values and the predicted seasonal values are also presented in Figs. 1 and 1 a. The cumulative per cent distribution of the lipid values is shown in Fig. 2 and in Tables 20—24 in the Appendix.

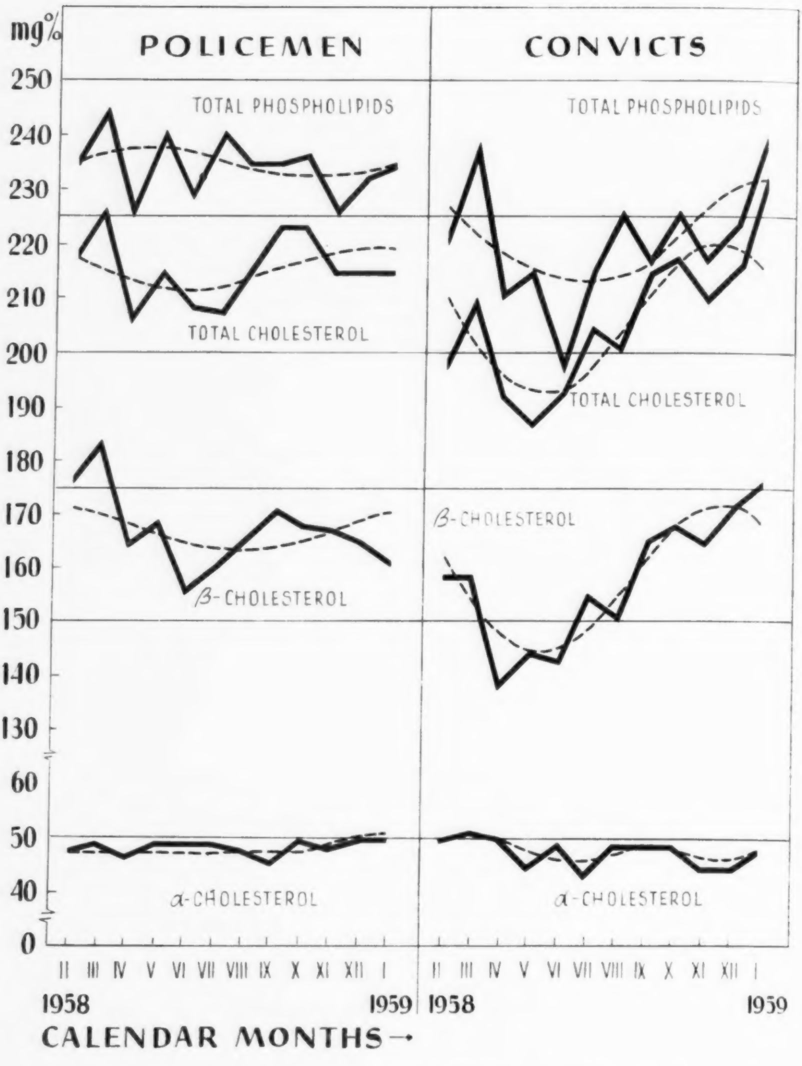

Fig. 1. — Seasonal variations of serum lipids: monthly median values (————) and predicted seasonal values (- - - -). The total cholesterol and β-cholesterol values in the group of convicts show significant seasonal variations.

Seasonal Variations

The main object of the present study was to find out whether periodical fluctuations in serum lipids accompanying the succession of the seasons occur. For this purpose the monthly median lipid values were statistically treated. In order to ascertain which lipid values the changes related to, the cumulative per cent distribution of the values was calculated for each month.

The *total phospholipid* values in the group of policemen showed no seasonal variation. By contrast, in the group of convicts a clear tendency towards a decrease in spring and summer and an increase in autumn and winter was discernible, but the changes were not statistically significant (P 0.1). The lowest median value, 199 mg. per 100 ml., was noted in June and the highest values, 239 mg. per 100 ml. and 240 mg. per 100 ml., were noted in March and January.

Total cholesterol in the group of policemen showed no seasonal variations, although the values were lowest in spring and summer. By contrast, in the group of convicts total cholesterol fell in summer and rose in winter, and the changes were significant (P 0.025). In this group the minimum value for total cholesterol (median) was observed in May (187 mg. per 100 ml.), the maximum value in January (232 mg. per 100 ml.). From the values for February and March the drop to the values for April and May was considerable. In the autumn the values began to rise, reaching the maximum in the middle of the winter.

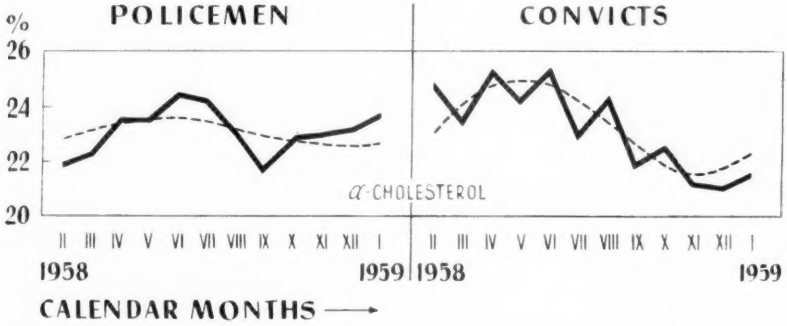

Fig. 1.a. — Seasonal variations of α-cholesterol in per cent of total cholesterol: monthly median values (————) and predicted seasonal values (- - - -). The values in the group of convicts show significant seasonal variations.

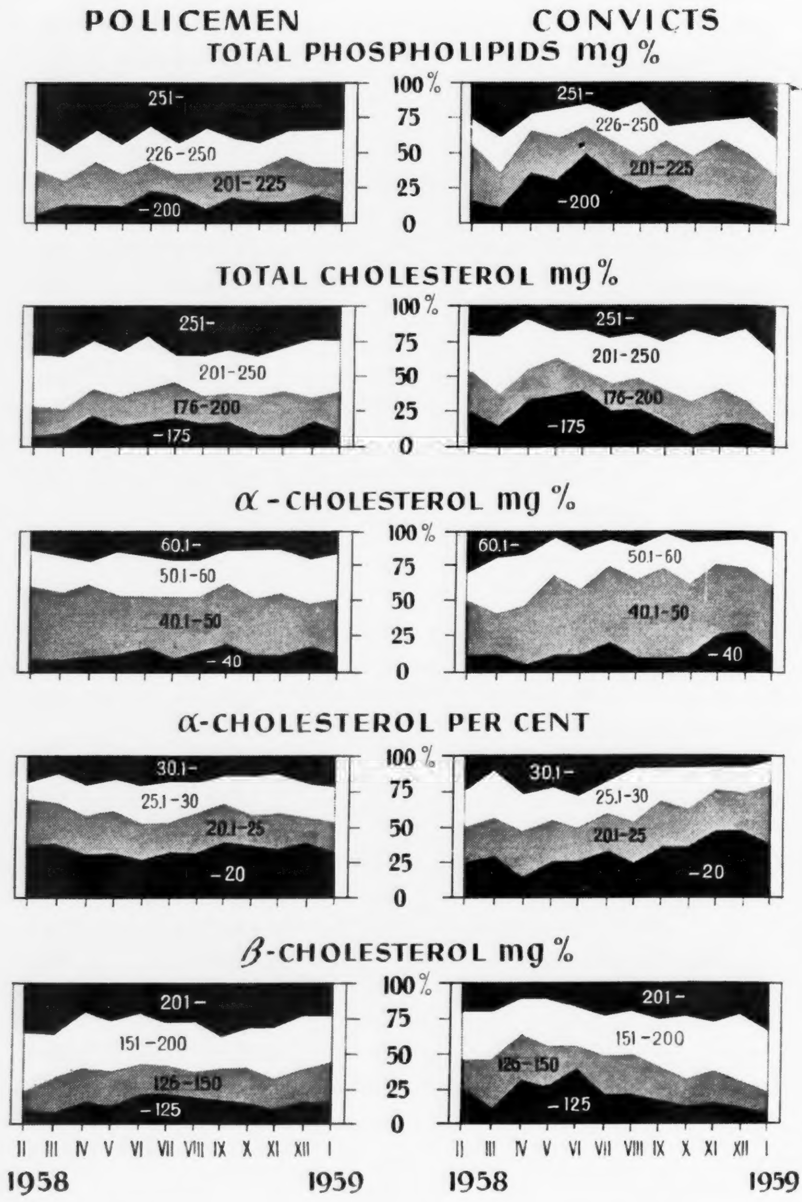

Fig. 2. — Cumulative per cent distribution of serum lipids. In the group of convicts the proportion of low values for total phospholipids, total cholesterol and β-cholesterol increased in spring and summer, the proportion of low values for α-cholesterol in per cent of total cholesterol increased in winter. In the group of policemen there was no seasonal trend.

The *α-cholesterol* values showed no seasonal trend in either group. The changes in *β-cholesterol* ran parallel to those observed in the total cholesterol values. In the group of policemen no significant seasonal variation was demonstrable in this lipid fraction, either. By contrast, in the group of convicts the β-cholesterol values showed significant seasonal changes (P 0.005). The lowest value, 139 mg. per 100 ml. (median), was noted in April. Low values were obtained in May and June, too (144 mg. per 100 ml. and 143 mg. per 100 ml.). The highest values, 171 mg. per 100 ml. and 176 mg. per 100 ml., were noted in December and January.

The ratio of *α-cholesterol* to total cholesterol varied in the same way in the two groups, being highest in spring and summer and lowest in winter. In the group of policemen the changes were not significant, however. By contrast, in the group of convicts the seasonal trend was significant (P 0.005). In this group the lowest value, 21.2 per cent, was observed in December and the highest value, 25.2 per cent, in April and June, whilst the value for May was 24.3 per cent.

When the *cumulative per cent distribution* was analysed (Fig. 2, Tables 20—24 in the Appendix), no seasonal variation was found in the group of policemen, but in the group of convicts a seasonal trend in the distribution of the lipid values emerged.

In the group of convicts the *total phospholipid* values showed a seasonal trend, inasmuch as the proportion of low values increased in the summer months. In June there were 51 per cent values under 200 mg. per 100 ml. against only 9 per cent in January. Of the *total cholesterol* values the proportion under 200 mg. per 100 ml. was 63 per cent in May against 17 per cent in January. In regard to the high values over 251 mg. per 100 ml. no appreciable variation was noted. The changes in *β-cholesterol* ran parallel with the changes in total cholesterol. In spring and summer the low values increased, but the high values showed no seasonal trend. In June there were 40 per cent values under 125 mg. per 100 ml. against 9 per cent in January and March. The *α-cholesterol* values exhibited mainly a variation between 40.1—50 mg. per 100 ml.

and 50.1—60 mg. per 100 ml., but no clear seasonal trend was discernible. By contrast, the ratio of *α-cholesterol* to total cholesterol showed seasonal changes in the group of convicts, inasmuch as the number of high values increased in summer and the number of low values increased in winter. In November and January, the ratio of α-cholesterol to total cholesterol was under 25 per cent in 77 per cent of cases against 49 per cent in April and June. The most striking feature in the variation of the per cent distribution was the seasonal trend observable in the β-cholesterol values.

Individual Lipid Levels

The individual mean serum lipid values and standard deviations of the mean are shown in Table 11 in the Appendix. The monthly serum cholesterol values are shown in Table 10 in the Appendix. The policemen and the convicts were classified in groups according to lipid level (Tables 4, 5, 6).

In the group of policemen the mean values for *total phospholipids* ranged from 177 to 319 mg. per 100 ml., the mean value for the group being 240.2 mg. per 100 ml. In the group of convicts the range was from 183 to 281 mg. per 100 ml., the mean value being 226.1 mg. per 100 ml. Of the policemen 9 per cent had mean values over 300 mg. per 100 ml., whilst the highest mean value in the group of convicts was 281 mg. per 100 ml. Mean values $\leqq$ 200 mg. per 100 ml. were noted in 11 per

TABLE 4

Policemen and Convicts Classified According to Total Phospholipid Level: Mean Values for Standard Deviation, Standard Error of the Mean and Range of Standard Deviation in the Subgroups

Total Phospholipid mg%	$\leqq$ 200	201—250	251—300	$\geqq$ 301
Policemen				
No.	5	23	13	4
SD	11.5 ± 1.45	15.4 ± 1.15	22.8 ± 1.97	
range of SD	7.3—15.8	7.4—27.6	14.2—29.0	21.7—39.2
Convicts				
No.	5	21	9	—
SD	15.1 ± 1.41	20.2 ± 1.23	19.5 ± 2.45	
range of SD	11.8—19.4	10.2—31.4	9.3—30.8	

cent of the policemen and in 14 per cent of the convicts. In the group of policemen 51 per cent, and in the group of convicts 60 per cent, had mean values between 201 and 250 mg. per 100 ml., whilst mean values between 251 and 300 mg. per 100 ml. were noted in 29 per cent of the policemen and 26 per cent of the convicts.

In order to measure the variation, the *standard deviation of the total phospholipid* values was determined. In the group of policemen the average individual standard deviation was 17.8 mg. per 100 ml., the range being from 7 to 39 mg. per 100 ml. In the group of convicts the standard deviation was of the same magnitude, the average being 19.3 mg. per 100 ml., whilst the individual values ranged between 9 and 31 mg. per 100 ml. The standard deviation was under 25 mg. per 100 ml. in 82 per cent of the policemen and 83 per cent of the convicts.

In the group of policemen the standard deviation was higher in individuals with high phospholipid values (P 0.001), whilst no such correlation was demonstrable in the group of convicts.

The *total cholesterol* values varied between 147 and 309 mg. per 100 ml. in the group of policemen and between 154 and 289 mg. per 100 ml. in the group of convicts. As indicated in the foregoing (Table 3), the mean value for the former group (224.1 mg. per 100 ml.) was higher than the mean value for the latter (211.8 mg. per 100 ml.). The mean value was $\leqq$ 200 mg. per 100 ml. in 40 per cent of the policemen and 43 per cent of the

TABLE 5

Policemen and Convicts Classified According to Total Cholesterol Level: Mean Values for Standard Deviation, Standard Error of the Mean and Range of Standard Deviation in the Subgroups

Total Cholesterol mg%	$\leqq$ 200	201—250	251—300	$\geqq$ 301
Policemen				
No.	18	15	8	4
SD	13.7	17.0	23.7	29.7
	± 0.97	± 0.82	± 2.36	± 1.71
range of SD	7.16—21.5	11.7—22.7	15.9—37.9	27.5—34.4
Convicts				
No.	15	13	7	—
SD	19.9	20.8	22.6	
	± 1.47	± 1.73	± 1.98	
range of SD	11.0—31.4	14.3—36.2	13.9—28.9	

convicts. The mean value was 201—250 mg. per 100 ml. in 33 per cent of the policemen and in 37 per cent of the convicts, 251—300 mg. per 100 ml. in 18 per cent of the policemen and 20 per cent of the convicts. Mean values over 300 mg. per 100 ml. were noted only in the group of policemen — in 9 per cent of the men.

The *standard deviation of the total cholesterol* values was an average of 18.0 mg. per 100 ml. in the group of policemen, the individual values ranging between 7 and 38 mg. per 100 ml. In the group of convicts the standard deviation was somewhat higher (P 0.05) than in the group of policemen, i.e. 21.1 mg. per 100 ml., whilst the individual values ranged between 11 and 36 mg. per 100 ml. The standard deviation was under 25 mg. per 100 ml. in 84 per cent of the policemen and 80 per cent of the convicts.

The difference between the highest and the lowest cholesterol values noted during the year varied in the group of policemen between 19 and 104 mg. per 100 ml. and in the group of convicts between 39 and 124 mg. per 100 ml. In only about 24 per cent of the policemen and 8 per cent of the convicts was the difference between the values for two successive months invariably under 30 mg. per 100 ml. This difference was over 50 mg. per 100 ml. at least once during the year in 35 per cent of the policemen and 44 per cent of the convicts. The greatest difference observed between two successive determinations was 86 mg. per 100 ml. in the group of policemen and 88 mg. per 100 ml. in the group of convicts.

In the group of policemen there was a highly significant (P 0.001) correlation between high cholesterol values and a high standard deviation, but in the group of convicts no significant correlation was observable on this point.

The *α-cholesterol* values in the group of policemen and the group of convicts did not differ significantly from each other. In the former, the individual mean values ranged from 38 to 66 mg. per 100 ml., the mean for the group being 49.9 mg. per 100 ml. In the latter, the range was from 30 to 60 mg. per 100 ml., the group mean being 48.1 mg. per 100 ml. A value over 60 mg. per 100 ml. was noted in 13 per cent of the policemen and 3 per cent of the convicts (one subject). In both groups 31 per cent had mean values between 50.1 and 60 mg. per 100 ml. A

mean value $\leqq$ 50 mg. per 100 ml. was observed in 56 per cent of the policemen and 66 per cent of the convicts, a mean value $\leqq$ 40 mg. per 100 ml. in only 2 policemen and 4 convicts (4 and 16 per cent, respectively).

The standard deviation of the α-cholesterol values was of the same magnitude in the two groups. In the group of policemen the mean value was 5.2 mg. per 100 ml., in the group of convicts 5.4 mg. per 100 ml. In the former, the standard deviation of the individual values ranged from 1 to 11 mg. per 100 ml., in the latter from 3 to 14 mg. per 100 ml. The standard deviation was under 10 mg. per 100 ml. in 95 per cent of the policemen and 97 per cent of the convicts, under 5 mg. per 100 ml. in 54 per cent in both groups.

The *ratio of α-cholesterol* to total cholesterol was of the same magnitude in the group of policemen and the group of convicts, i.e. 23.3 per cent and 23.6 per cent, respectively. In the former group the ratio varied from 13 to 33 per cent, in the latter from 14 to 40 per cent. The individual standard deviation varied in both groups between 1 and 5 per cent, the average being 2.5 per cent in the group of policemen and 2.8 per cent in the group of convicts.

The variation in *β-cholesterol* ran parallel with the variation in total cholesterol. In the group of policemen the individual values ranged from 98 to 267 mg. per 100 ml., the mean for the

TABLE 6

Policemen and Convicts Classified According to α-Cholesterol Level, α-Cholesterol in Per Cent of Total Cholesterol and β-Cholesterol Level

α-Cholesterol mg%	$\leqq$ 40	40.1—50	50.1—60	> 60
Policemen No.	2	23	14	6
Convicts No.	4	19	11	1

α-Cholesterol per cent	$\leqq$ 15	15.1—20	20.1—25	25.1—30	> 30
Policemen No.	5	10	10	14	6
Convicts No.	1	7	13	12	2

β-Cholesterol mg%	$\leqq$ 150	151—200	201—250	251—300
Policemen No.	18	16	8	3
Convicts No.	15	14	6	—

group being 174.9 mg. per 100 ml. In the group of convicts the corresponding values were 92—240 mg. per 100 ml. and 163.3 mg. per 100 ml. The variation of the individual values expressed as standard deviation was from 5 to 39 mg. per 100 ml. in the group of policemen, the average being 18.6 mg. per 100 ml. In the group of convicts the standard deviation was somewhat larger — just as was the standard deviation of the total cholesterol values — the individual values ranging from 10 to 38 mg. per 100 ml. and the average for the group being 21.1 mg. per 100 ml.

AGE AND SERUM CHOLESTEROL

The median age of the policemen and the convicts was 33.2 and 32.7 years, respectively. In regard to age distribution there was no appreciable difference between the two groups.

The ages of the subjects are shown in Table 11 in the Appendix, the number of subjects and the cholesterol values in the different age groups in Table 7.

In the group of policemen the cholesterol level was found to rise from a mean value of 202 mg. per 100 ml. in those under 30 years of age to 251 mg. per 100 ml. in the age group 35—39 years. In those over 40 years old the mean value was 232 mg. per 100 ml. Correspondingly, in the group of convicts the cholesterol level rose from 196 mg. per 100 ml. in those under 30 years old to 250 mg. per 100 ml. in the age group 45—49 years.

TABLE 7

Policemen and Convicts Classified According to Age: Mean Total Cholesterol, Standard Error of the Mean and Range of Total Cholesterol in the Subgroups

Age	≦ 29	30—34	35—39	40—44	45—49
Policemen					
No.	15	12	11	5	2
Total cholesterol	201.6	223.5	250.8	231.8	
	± 9.62	± 14.17	± 13.48	± 12.39	
range	149—303	147—292	171—309	191—294	
Convicts					
No.	11	12	4	4	4
Total cholesterol	196.2	204.5	220.8	229.3	250.1
	± 8.06	± 9.02	± 27.70	± 17.73	± 21.43
range	162—238	153—251	167—286	181—260	202—289

In regard to the youngest age group and those over 40 years old the difference was inconsiderable between the convicts and the policemen, whilst in the age group 30—39 years the convicts exhibited somewhat lower values.

In neither group was a progressive rise in the cholesterol or other lipid values observable during the year of the study.

On the basis of the cholesterol values in the different age groups it appears that the cholesterol level rises with age, but the groups are too small to permit any definite conclusions to be drawn.

WEIGHT, SKINFOLD THICKNESS AND SERUM CHOLESTEROL

In order to assess nutritional state, the weight, relative body weight and upper arm and subscapular skinfold sum were determined (Table 12, 13 in the Appendix).

In the present study no correlation was observable between cholesterol and body weight. This is also seen in Fig. 3. A comparison of the changes in weight and changes in cholesterol based on the monthly records revealed no correlation on this point, either. Furthermore, the changes in weight were found to exhibit no seasonal variation (Table 19 in the Appendix).

The relative body weight was 0.90—1.33 in the group of policemen, 0.78—1.13 in the group of convicts. When the policemen and the convicts were classified in groups according to relative body weight (Table 8), no significant difference in

TABLE 8

Policemen and Convicts Classified According to Relative Body Weight: Mean Total Cholesterol and Standard Error of the Mean in the Subgroups

Relative Body Weight	$\leqq$ 0.89	0.90—0.99	1.00—1.09	1.10—1.19	$\geqq$ 1.20
Policemen					
No.	—	13	12	13	7
Total cholesterol		213.6	236.4	221.4	227.9
		± 12.48	± 12.93	± 14.56	± 11.24
Convicts					
No.	5	13	17		—
Total cholesterol	235.3	201.3	212.9		
	± 16.49	± 10.99	± 8.38		

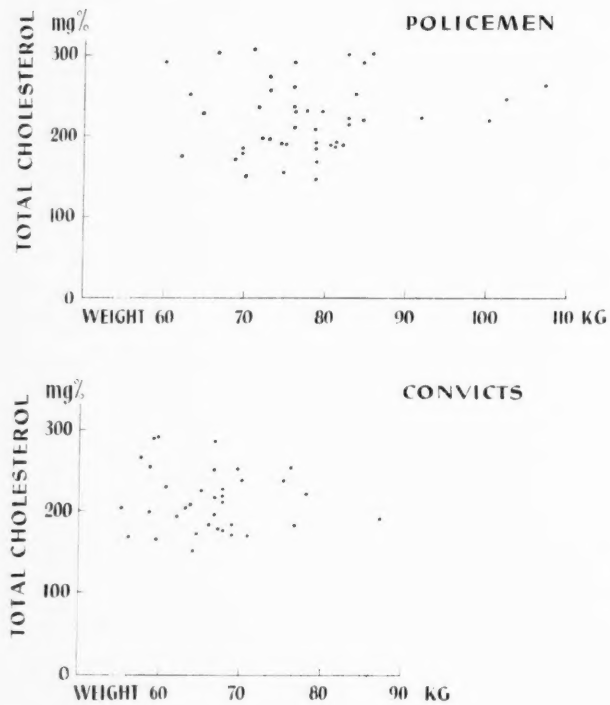

Fig. 3. — Correlation between mean total cholesterol and mean body weight.

TABLE 9

Policemen and Convicts Classified According to Arm and Subscapular Skinfold Sum: Mean Total Cholesterol and Standard Error of the Mean in the Subgroups. Significance of Difference between Test Groups in the Two Groups

Skinfold Sum	10—14.5	15—19.5	20—24.5	25—29.5	30—34.5	≥ 35	P
Policemen							
No.	4	8	10	12	5	6	
Total cholesterol	171.3 ± 5.83	203.3 ± 10.58	229.9 ± 15.35	223.4 ± 10.67	252.6 ± 20.75	255.3 ± 19.84	
Test groups	I		II		III		0.01
Convicts							
No.	9	12	8		5		
Total cholesterol	212.9 ± 15.31	206.9 ± 10.96	213.9 ± 9.82		208.6 ± 17.97		
Test groups	I		II				..

cholesterol values was observed between the subjects with a relative body weight of over 1.00 and those with a relative body weight of under 1.00.

Furthermore, the policemen and the convicts were classified in groups according to upper arm and subscapular skinfold sum (Table 9), and the difference between the cholesterol values of the groups was tested. There was a significant correlation (P 0.01) between the skinfold sum and cholesterol in the group of policemen, but not in the group of convicts.

INFECTION AND SERUM CHOLESTEROL

Throughout the period of study attention was paid to the state of health of the subjects. They were questioned on this point, and the erythrocyte sedimentation rate was determined, every month.

Slight infectious diseases occurred, such as common cold, fever, furuncles. Such diseases occurred in the group of policemen 27 times and in the group of convicts 13 times during the year in question. The cases were evenly distributed over the different months. On the basis of these 40 cases the effect of infection on serum cholesterol was studied, attention being paid to the difference between the values obtained before and after infection and the difference between the latter values and the values obtained one month later.

On comparison of the cholesterol values before and after infection 28 cases exhibited a fall of 5—80 mg. per 100 ml. and 6 cases a rise of 1—25 mg. per 100 ml., whilst in 4 cases the level remained unchanged. Statistically, there was a significant decrease in cholesterol associated with infection (Sign test; P 0.01).

On comparison of the values obtained immediately after infection exhibiting a significant fall with the values for the next month, a rise of 2—71 mg. per 100 ml. was observed in 29 cases and a fall of 5—34 mg. per 100 ml. in 9 cases. The rise was statistically significant (Sign test; P 0.01).

An erythrocyte sedimentation rate over 10 mm/hr was observed in a total of 15 cases in the two groups together. Serum cholesterol fell in 11 of these by 7—34 mg. per 100 ml. and rose

in 3 by 2—22 mg. per 100 ml., whilst the level remained the same in one case. The fall in serum cholesterol was almost significant (t-Test; P 0.05).

When the erythrocyte sedimentation rate had returned to normal, a rise in cholesterol of 4—29 mg. per 100 ml. was observed in 13 cases and a fall of 11—40 mg. per 100 ml. in 2. There was a significant correlation between the normalization of the erythrocyte sedimentation rate and the rise in cholesterol (Sign test; P 0.01).

In the present study it was, then, found that the serum cholesterol level dropped during infections. After recovery the cholesterol values again rose. Furthermore, it appeared that an increased erythrocyte sedimentation rate was associated with a fall in cholesterol, and normalization was associated with a rise in cholesterol. Consequently, when the variations occurring in serum cholesterol are studied, these factors must be taken into account.

DISCUSSION

The Serum Lipid Levels

In both the group of policemen (45 subjects) and the group of convicts (35 subjects) the serum lipid values obtained in the present study are in agreement with those previously noted in normal Finnish men (Nikkilä 1953, Miettinen 1956, Keys *et al.* 1958, Konttinen 1959).

In the group of policemen, which represents subjects living under normal environmental conditions, whilst convicts live under controlled conditions, the mean value for total phospholipids, 240.2 mg. per 100 ml., did not differ appreciably from the values obtained by Miettinen (1956) and Waris (1958) in normal Finnish men of the same ages. Their values, obtained by the same method of investigation, were 245 mg. per 100 ml. and 249 mg. per 100 ml., respectively. In Konttinen's (1959) series of young men (18—26 years old) the mean phospholipid level was somewhat lower, 221 mg. per 100 ml.

In regard to total cholesterol the mean level in the group of policemen, 224.1 mg. per 100 ml., was somewhat lower than the value obtained by Waris (1958) for normal Finnish men, using the same method of determination. Waris' mean value for men aged 21—40 years was 244 mg. per 100 ml. The present values in the group of policemen were also somewhat lower than those obtained by Keys *et al.* (1958) in Finnish men. In the younger age groups of policemen, however, the cholesterol values did not differ much from those noted by Keys *et al.* (1958). In regard to subjects over 40 years old, the values obtained by Keys *et al.* were clearly higher than those noted in the present group of policemen.

A rise in serum cholesterol with age, noted by many writers (e.g. Keys *et al.* 1950 b, c, Nikkilä 1955, Keys *et al.* 1958, Carlson 1960), seemed to be demonstrable in the present series, too, but the age groups were too small to permit any definite conclusions to be drawn.

In the group of policemen the distribution of cholesterol between the α- and β-fractions was more or less the same as has previously been observed in Finnish men. The α-lipoprotein cholesterol level was 49.9 mg. per 100 ml., which is somewhat higher than the values noted by Keys *et al.* (1958) in various age and occupational groups, i.e. 37—46 mg. per 100 ml., but lower than Miettinen's (1956) value of 62 mg. per 100 ml., Waris' (1958) 55—57 mg. per 100 ml. and Konttinen's (1959) 56 mg. per 100 ml. The ratio of α-cholesterol to total cholesterol was 23.3 per cent, which tallies with the results obtained by Miettinen (1956) and Waris (1958), i.e. 26 and 24 per cent. Konttinen's (1959) corresponding value for young men was 27 per cent. The mean value for β-cholesterol obtained in the present study, 174.9 mg. per 100 ml., is of the same magnitude as the values reported by Miettinen (1956), Waris (1958) and Keys *et al.* (1958).

The Differences in Serum Lipid Levels between the Groups

The serum lipid level was lower in the group of convicts than in the group of policemen. Total cholesterol was significantly lower in the convicts (211.8 mg. per 100 ml.) than in the policemen (224.1 mg. per 100 ml.). The level of total phospholipids, too, seemed to be lower in the group of convicts (226.1 mg. per 100 ml.) than in the group of policemen (240.2 mg. per 100 ml.), although the difference was only almost significant. By contrast, there was no significant difference between the two groups in regard to α-cholesterol, β-cholesterol and the ratio of α-cholesterol to total cholesterol. Josephson *et al.* (1952), too, found that the level of serum cholesterol was lower in Finnish convicts than in other healthy Finnish men. Furthermore, Gofman *et al.* (1956) reported lower cholesterol and Sf 12—20-lipoprotein values in convicts than in other normal subjects, while in a series of convicts studied by Thomas *et al.* (1961) the serum cholesterol level was in agreement with the cholesterol level previously observed in students of the same age (Thomas and Eisenberg 1957, Thomas and Murphy 1958).

When the individual variations in lipids were analysed, both the group of policemen and the group of convicts were found

to include some individuals exhibiting wide variations and others with fairly stable lipid levels. In the group of policemen the widest variations were observed in those exhibiting high cholesterol levels, but in the group of convicts no such correlation was demonstrable.

It is striking that there seemed to be somewhat wider individual variations in the group of convicts than in the group of policemen. Under the controlled and regular living conditions in prison it might have been expected that the lipid levels would remain more constant. In a series of convicts studied by Thomas *et al.* (1961), the standard deviation of total cholesterol was 10.8—49.0 mg. per 100 ml., which is in agreement with the standard deviation of 11.0—36.2 mg. per 100 ml. noted in the present group of convicts, in which the mean value was 21.1 mg. per 100 ml. In the group of policemen the standard deviation of total cholesterol was 7.2—37.9 mg. per 100 ml., the mean value being 18.0 mg. per 100 ml. It appears, then, that the variability of the lipids is not to any considerable degree dependent on regularity of living conditions.

In an attempt to account for the differences in lipid levels between the group of policemen and the group of convicts, the difference in build attracts attention, among other things. The policemen were taller and heavier, their skinfold was thicker and the biacromial and bicristal measures, too, were larger than in the group of convicts. According to certain writers (e.g. Mjassnikov 1927, Petersen and Levinson 1930, Gildea *et al.* 1936, Esgaard 1943, Gertler *et al.* 1950 a, Kornerup 1950, Tanner 1951), subjects of sturdy build have higher lipid levels than persons of slender build. By contrast, Goldbloom (1952) and Lindholm (1956), among others, failed to detect any correlation between serum lipids and body build.

Furthermore, it is possible that the convicts and the policemen differed from each other in regard to hereditary and racial properties. A large number of investigators have come to the conclusion that external factors, e.g. socio-economic status and living conditions, influence the serum lipid level more than do hereditary properties (e.g. Keys *et al.* 1955 c, 1956, 1958, Walker and Arvidsson 1954, Brock and Bronte-Stewart 1955, Bronte-Stewart *et al.* 1955, Mann *et al.* 1955 a, b, Bersohn and Way-

burne 1956, Larsen 1957, Toor *et al.* 1957, 1960, Yudkin 1957, Bloomberg *et al.* 1958, Gupta *et al.* 1958, Ruskin *et al.* 1958, Whyte *et al.* 1958, Mathur *et al.* 1959, Padmavati *et al.* 1959), certain hereditary metabolic diseases excepted (e.g. essential familial hypercholesteraemia; Thannhauser 1960, and others). The significant influence of external factors is also illustrated by an observation made by Keys *et al.* (1958) in a study on the cholesterol values of Finnish men. They noted a difference in cholesterol level between men living in eastern and western Finland, respectively, whilst subjects living in the same place had similar cholesterol levels irrespective of the part of Finland where they came from.

It has been shown in many studies that obese people have higher serum lipid levels than subjects of normal weight (e.g. Mjassnikov 1927, Tanner 1951, Gofman *et al.* 1952, Walker 1953, Gupta *et al.* 1958, Padmavati *et al.* 1959), or that there is some correlation between obesity and serum lipids (Keys 1954), but numerous other investigators have failed to observe any direct correlation on this point (e.g. Bruger and Pointdexter 1934, Peters and Man 1943, Keys 1949, Gertler *et al.* 1950 a, Groen *et al.* 1952, Lindholm 1956, Karvonen *et al.* 1959). In the present study no correlation was observed between serum cholesterol and weight, nor between serum cholesterol and relative body weight.

One way of assessing a subject's nutritional states is to measure his skinfolds. Tanner (1951) observed a correlation between skinfold and serum lipids, whilst Keys (1954) and Keys *et al.* (1960) observed such a correlation only in certain groups of subjects, and other writers have failed to detect any correlation (e.g. Karvonen *et al.* 1959, Thomas and Garn 1960). In the present study a significant correlation between cholesterol and skinfold sum was observed in the group of policemen, but not in the group of convicts.

The physical activity to which the convicts were exposed was relatively slight, a few men excepted who performed heavy manual work. On the other hand, the work of the policemen, too, was fairly light. It appears that in regard to physical activity there was no difference between the two groups which could have been responsible for the differences in lipid level.

Since psychic stress cannot be measured, it is difficult to say whether any differences in psychic factors contributed to the differences in lipid level.

By contrast, in regard to diet there was a definite difference between the two groups. The amount of fat in the diet of the policemen, estimated at 35 per cent of the total calorie value, was considerably higher than the amount of fat in the diet of the convicts, which was estimated at about 25 per cent (see p. 49). The difference in the consumption of fat may in part account for the differences observed in the lipid levels of the two groups.

Seasonal Variations in the Serum Lipid Levels

In the convicts a seasonal variation was observed in the levels of serum total cholesterol, β-cholesterol and the proportion of α-cholesterol. The highest total cholesterol and β-cholesterol values were noted in the winter and the lowest values in late spring and summer, whilst the ratio of α-cholesterol to total cholesterol was lowest in the winter and highest in the summer. By contrast, in the group of policemen no seasonal variations were observed in the serum lipid values.

A seasonal or thermal effect on the blood and plasma volumes has been clearly established (e.g. Barcroft *et al.* 1922, Bazett 1938, Bazett *et al.* 1940, Maxfield *et al.* 1941, Doupe *et al.* 1957). Since the possibility had to be taken into account that the changes in lipid level observed might be due to changes in blood volume, determinations of plasma volume and blood volume were made on all subjects every second month. The variations in lipid level could not, however, be accounted for by the changes observed in the plasma and blood volumes (Paloheimo, unpublished).

In Finland, seasonal changes in the climate are considerable. In Helsinki, there is a sharp rise in temperature from February and March over April, May and June to the maximum in July (Fig. 4). Subsequently, the temperature begins to drop, the difference between July, on the one hand, and December and January, on the other, being very marked. During the period of this study, from February 1958 to January 1959, the monthly mean temperatures were somewhat lower than normal, the

autumn months from September to November excepted, which were warmer than normal (Fig. 4). The period of the study was also characterized by wide, but transient temperature fluctuations throughout the year.

On scanning the available literature only a few papers dealing with the influence of external temperatures on human serum lipids were found. These are short-term studies, and in some of them an increase in cholesterol at low temperatures (Kuhl *et al.* 1955) or a decrease at high temperatures (e.g. Marchioni and Ottenstein 1931, Walinski and Bleisch 1939) has been observed, in others no clear changes (Ott 1948). In the bovine, serum cholesterol has been found to go up when the external temperature goes down, and *vice versa* (Diven *et al.* 1958).

Ultraviolet radiation, which shows a marked seasonal variation, has attracted more attention than temperature in studies on human serum lipids. The amount of sunshine and ultraviolet light begins to rise abruptly in the spring. According to Seppä-Kivalo (1954), in Helsinki the amount of ultraviolet radiation is approximately the same from year to year (Fig. 5). The amount of ultraviolet light increases markedly from March to

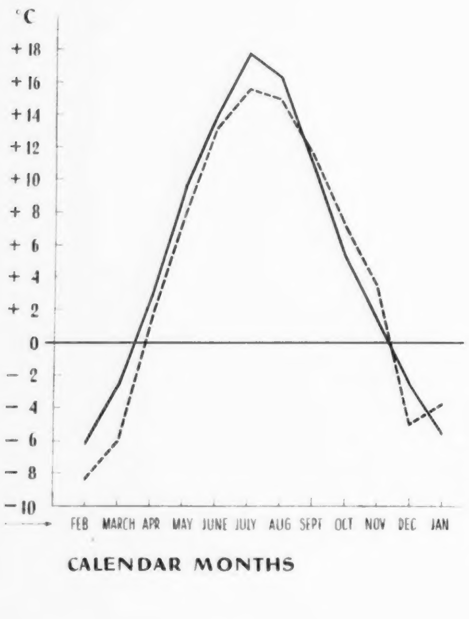

Fig. 4. — The normal temperature curve (1921—1950) and the temperature curve for the time of this study (1958—1959) in Helsinki. (normal ———, this study - - - -)

May, and further until the maximum is reached in July. Subsequently, there is a marked drop towards the winter months. When the mean temperature curve for the year (Fig. 4) is compared with the curve illustrating the amount of ultraviolet radiation (Fig. 5), it is seen that they run nearly parallel courses.

It has been reported that ultraviolet radiation and sunlight bring about a decrease in cholesterol (e.g. Loeper and Degos 1930, Altschul and Herman 1953, Altschul 1955 a, b, c, Plavsic *et al.* 1958), whilst short-term exposition to strong sunlight and ultraviolet radiation causes a transient increase in cholesterol (e.g. Malczynski 1928, 1930, Malczynski and Lankosz 1933, Laureus 1938, Caccialanza 1959).

The greatest changes in the lipid levels of the convicts occurred in the spring, when a decrease began in March—May. Pucher *et al.* (1934) emphasized that a marked transient decrease in cholesterol occurred in spring. In a series of con-

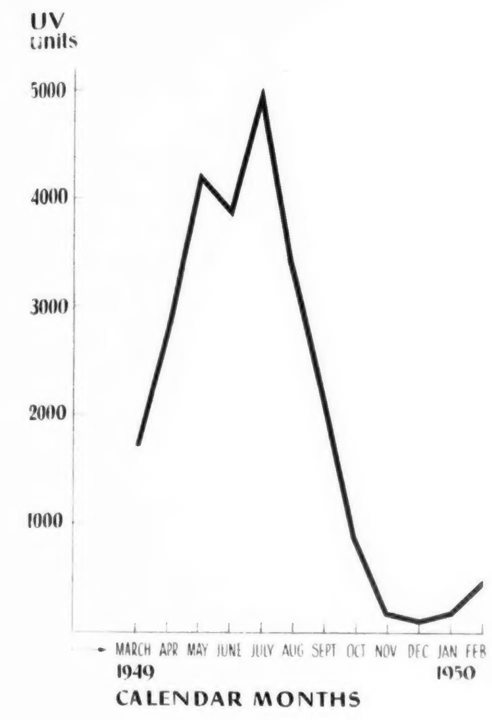

Fig. 5. — The amount of ultraviolet radiation in Helsinki from March, 1949 to February, 1950. (Seppä—Kivalo 1954).

victs Thomas *et al.* (1961), too, observed »a sharp decline from March to May when the lowest point of the year is reached».

When the present two groups are compared from the standpoint of possible exposition to the influence of external temperatures and ultraviolet light, it is obvious that the policemen were more exposed. Irrespective of the weather, they spent many hours outdoors every day on watch-duty or otherwise in outdoor work, and they also often spent their leisure in the open air, whilst with a few exceptions the convicts worked indoors in both summer and winter. As a rule, they spent little time in the open air.

It might be suggested that the drop in serum lipids observed in the group of convicts in the spring was caused by the increase in ultraviolet radiation and the rise in temperature occurring in this season. It should be recalled that the lowest lipid values were noted in the summer, the highest in the winter. If changes in ultraviolet radiation and/or external temperature were the only source of seasonal variations, this relationship would probably have been reflected in the values obtained in the group of policemen. Since this was not the case, it is obvious that changes in ultraviolet radiation and external temperatures cannot be the only factors responsible for the seasonal variation in the lipid values observed in the group of convicts, although the possibility of a relationship cannot be excluded.

It is a well-known fact that the incidence of infectious diseases rises in spring and autumn (e.g. de Rudder 1952). According to various writers, infectious diseases may cause a decrease in serum lipids, whilst revocery is associated with a return to the previous level, or the previous level is exceeded (e.g. Luden 1917, Denis 1917, Stepp 1918, Kipp 1920, Lavergne and Kissel 1934, Stoesser and McQuarrie 1935, Stoesser 1938, Steiner and Turner 1940, Nishishita 1941, Hodges *et al.* 1943, Thomas and Eisenberg 1959). This finding was confirmed in the present study. Twenty-seven policemen and 13 convicts developed mild infections of short duration, on account of which they did not have to stay away from work, however. In 10 policemen and 5 convicts the erythrocyte sedimentation rate exceeded 10 mm/hr, which was regarded as the upper limit of the normal. The cholesterol level was found to drop in connection with infection

and to rise after recovery. Furthermore, the cholesterol level fell when the erythrocyte sedimentation rate rose and rose when the latter returned to normal. The distribution of the cases of infection over the year of study exhibited no seasonal differences. Hence, the occurrence of infections does not seem to bear any relationship to the seasonal variation observed in the serum lipid values in the group of convicts.

In studies dealing with serum lipids the greatest degree of attention seems to have been paid to the role of dietary factors. It has been shown that the amount and kind of dietary fat essentially influence the serum lipid level. In studies performed in various countries a correlation has been observed between the consumption of fat and serum lipids, cholesterol in particular (e.g. Bronte-Stewart *et al.* 1955, Keys *et al.* 1955 a, Keys *et al.* 1958, Padmavati *et al.* 1959). As a rule, higher socio-economic level implies a larger consumption of fat and higher serum lipid levels (e.g. Bronte-Stewart *et al.* 1955, Schrimshaw *et al.* 1957, Toor *et al.* 1957, 1960, Yudkin 1957, Ruskin *et al.* 1958, Mathur *et al.* 1959, Padmavati *et al.* 1959). Small changes in dietary protein do not cause changes in the serum lipid level (e.g. Bronte-Stewart *et al.* 1956, Keys and Anderson 1957, Albanese *et al.* 1959). By contrast, low protein feeding brings about a decrease in cholesterol and phospholipids, (e.g. Furman *et al.* 1958, Olson *et al.* 1958). In the present study, the amount of protein in the diet of both the policemen and the convicts must be regarded as adequate.

The diet of the policemen was not subjected to detailed examination, but from answers to questions it was concluded that it consisted of ordinary Finnish food. According to a study by Roine *et al.* (1958), the amount of fat in the ordinary Finnish diet constitutes about 35 per cent of the total calorie value. The diet of the Finnish army contains fat to about 30 per cent of the total calorie value (Konttinen 1959). In the prison diet the proportion of fat was only about 20—22.5 per cent of the total calorie value. When the foodstuffs bought by the convicts are added, it may be concluded that the proportion of fat in their diet constituted 25 per cent, at the most.

Roine *et al.* (1958) noticed no differences in the diet in summer and winter in regard to the amount of fat, nor in regard

to the amount of fatty acids. They studied people living on the countryside. It is possible that in other groups of subjects seasonal dietary changes would be detected. In a series of convicts Thomas *et al.* (1961) found that there was a difference in the intake of fat between summer and winter, the consumption being smaller in summer. They stated, however, that »it is difficult to determine whether a change in dietary fat was responsible for any part of the seasonal effect, but it seems unlikely that such a change, if present, was very large». During the period of the present study no seasonal changes in the diet of the convicts could be established. In regard to the diet of the policemen it seems possible that the consumption of vegetables was larger in the summer, but on questioning the men no evidence of dietary changes could be elicited.

When dietary animal fat is replaced by vegetable fat, serum cholesterol has been found to go down (e.g. Groen *et al.* 1952, Kinsell *et al.* 1953, 1954, Ahrens *et al.* 1954, Anderson *et al.* 1957, Turpeinen *et al.* 1960). A similar observation has often been made when unsaturated vegetable fats have been added to the diet (e.g. Linko 1957, Beveridge *et al.* 1956, 1958, Ahrens *et al.* 1957, 1959, Malmros and Wigand 1957), but Nikkilä and Jokipii (1959), Perkins *et al.* (1958) and others failed to detect any drop in lipid level after the addition of maize oil and sunflower seed oil to the diet. Vegetable oils also contain phytosterol, β-sitosterol, among other things. The addition of this substance to the diet has been found to cause a decrease in serum cholesterol (e.g. Pollak 1953, Farquhar *et al.* 1956, 1958, Beveridge *et al.* 1958), inconsistent changes (Kalliomäki *et al.* 1957) or no changes at all (e.g. Wilkinson *et al.* 1955).

If in the group of policemen the consumption of vegetables was larger in the summer than in the winter, an accentuation of a possible seasonal variation might have been anticipated. But seasonal changes in the serum lipid values were observed only in the group of convicts, in which there were no dietary differences between summer and winter.

Since during the period of the study no appreciable seasonal dietary changes occurred, it seems unlikely that the seasonal variation in serum lipids detected was due to dietary factors.

During a long-term study changes in weight of the subjects

may occur. Many investigators have failed to detect any correlation between changes in weight and changes in serum lipid level (e.g. Pointdexter and Bruger 1935, Man and Gildea 1936, 1937, Astrup 1948, Pomeranze *et al.* 1952, 1953, Thomas and Murphy 1958, Konttinen 1959). Others (e.g. Anderson *et al.* 1952, Walker 1953, Milch *et al.* 1958) have noted a rise in serum lipids, cholesterol in particular, in association with weight increase. During periods of weight loss the lipid level has been found to drop (e.g. Keys *et al.* 1950 a, Walker and Wier 1951, Walker *et al.* 1953, Nichols *et al.* 1957) or to rise (e.g. Moore *et al.* 1954, 1955). It has been shown that changes in lipid values are significantly related not only to increase or loss of weight, but also to changes in the composition of the diet (e.g. Kartin *et al.* 1944, Anderson *et al.* 1956, Walker *et al.* 1957) and to physical activity during the period when weight changes occurred (e.g. Mann *et al.* 1955 b, Taylor *et al.* 1957 a, b, Schlessinger 1958).

In polar regions seasonal changes in body weight and skinfold have been observed, inasmuch as weight and skinfold have been found to increase in winter, but according to Edholm (1960) no relevant studies have been made in other climatic conditions.

In the present study no appreciable seasonal variation in body weight was observed. At the latitude of Helsinki, people are in general not exposed to such extreme climatic factors as in polar regions, and therefore it seems unlikely that the phenomenon in question, which is to be regarded as biological (Edholm 1960), would be observable here.

It seems obvious, then, that changes in weight do not significantly influence the serum lipids and that the seasonal variation in the lipid values observed in the present group of convicts cannot be attributed to this cause. A similar conclusion was drawn by Thomas *et al.* (1961), discussing the possible causes of the seasonal variation in serum cholesterol detected in a series of convicts.

The effect of physical activity on serum lipids has been studied in both short-term and long-term investigations by comparison of the serum lipid levels in relation to physical activity in certain groups of subjects.

During short periods of physical strain no marked changes in serum cholesterol have been observed (e.g. Beischer 1956, Karvonen *et al.* 1958), or slight changes in the cholesterol and phospholipid levels, the magnitude of which has been dependent on the degree of the strain (e.g. Fahring and Wacker 1932, Iakovlev 1952, Iakovlev *et al.* 1952, Mnukhina 1955). During longer periods of physical activity Konttinen (1959) and Montoye *et al.* (1959) detected no correlation between the changes in serum lipids and the degree of physical activity. In studies on different groups of subjects it has often been reported that serum lipid levels were lower in the physically active groups than in those performing sedentary work (e.g. Chailley-Bert *et al.* 1955, Keys *et al.* 1956, Mann *et al.* 1955 a, b, Toor *et al.* 1957, 1960, Brunner and Lobl 1957, Karvonen *et al.* 1958, Wiktor *et al.* 1960).

The policemen studied did not perform heavy physical work. In their leisure they practiced sports and outdoor exercises. Three men excepted, who performed heavy manual work, the convicts did not perform heavy physical work, either. In this group sports were practiced to a very limited degree. It cannot be definitely stated that there were no seasonal changes in the degree of physical activity, but if such changes occurred, they were too inconsiderable to permit any conclusions to be drawn. It is obvious that they cannot have been responsible for the seasonal variation in serum lipids observed in the group of convicts.

An interesting observation made in studies on the variability of serum lipids is that psychic factors may bring about changes in the serum lipid level. Situations causing emotional tension, either transient or protracted, are of common occurrence. In many relevant studies a rise in serum lipids, of which cholesterol has been most often determined, has been observed. Increased cholesterol levels have been ascribed to a variety of factors, e.g. difficulties in job, complications in the superior-subordinate relationship, unhappy love, economic difficulties, worries at home, political life, official duties and entering a new job (e.g. Groover 1957, Hammarsten *et al.* 1957, Rosenman and Friedman 1957, Friedman *et al.* 1958, Groover *et al.* 1960). Furthermore, a rise in serum cholesterol has been observed in connection with examinations and tests (e.g. Thomas and Murphy 1958,

Wertlake *et al.* 1958, Dreyfuss and Czaczkes 1959, Grundy and Griffin 1959). Peterson *et al.* (1960) performed an interesting study on ten hospital patients, five with highly variable cholesterol levels and five with very stable cholesterol levels. Psychic factors were found to cause a marked rise in cholesterol in a few hours. »The data suggest that certain situations appearing potentially to be stressful may induce rather striking changes in serum cholesterol within a few hours in selected individuals.» Immediately following an infection, physical exercise or emotional tension Groen *et al.* (1952) found that the serum cholesterol level had a tendency to fall. When »the stress period» was over, the cholesterol level rose.

It is impossible to evaluate psychic factors, since there is no objective method for their measurement. In the work of a policeman, situations causing psychic tension are sure to occur. Of the convicts some had outbursts of violence, bad temper or resistance to the jailer, which are to be regarded as displays of tension. These phenomena were evenly distributed over the year, however, and in the present study no evidence of the »Christmas stress» mentioned by Thomas *et al.* (1961) emerged.

As appeared in the description of the plan of study, in the group of convicts blood was invariably drawn in the morning under the same conditions. In the group of policemen blood was also drawn fasting in the morning, but some of the men had then already been on duty and others had come from their homes to their working places. It is difficult to evaluate the significance of this circumstance, but it may have contributed to the occurrence of random changes.

Summarizing, it may be stated that the seasonal variation in serum lipids observed in the group of convicts could not be attributed to any particular cause. It appears, therefore, that it is a biological phenomenon, the sum of many factors, which is not strong enough to be clearly noticeable except under conditions where life is extremely regular, as it is in prison, and where external influences are slight. Under normal conditions, such as were present in the group of policemen, the factors influencing the lipid level are so many and so variable that the seasonal trend cannot manifest itself.

SUMMARY

The purpose was to study the variations in serum lipid levels observable in healthy men during one year with special attention to the question of whether seasonal fluctuations occur.

The subjects were 45 policemen and 35 convicts. On these, monthly determinations were made of serum total phospholipids, total cholesterol, the cholesterol content of the α- and β-lipoprotein fractions separated by paper electrophoresis and the ratio of α-lipoprotein cholesterol in per cent of total cholesterol. Body weight was determined once a month. Height, the sum of upper arm and subscapular skinfold thickness and the biacromial and bicristal diameters were measured. In addition, relative body weight was determined.

In the group of policemen the following median values were obtained: height 180 cm, weight 78 kg, relative body weight 1.06, upper arm and subscapular skinfold sum 24 mm, biacromial diameter 39.5 cm and bicristal diameter 29.8 cm. In the group of convicts the corresponding values were as follows: height 173 cm, weight 67 kg, relative body weight 0.98, upper arm and subscapular skinfold sum 17 mm, biacromial diameter 37.9 cm and bicristal diameter 28.9 cm. The median age of the two groups was the same, about 33 years.

The mean values for total phospholipids and total cholesterol in the group of policemen, i.e. 240.2 mg. per 100 ml. and 224.1 mg. per 100 ml., were almost significantly and significantly higher than the corresponding values for the convicts, i.e. 226.1 mg. per 100 ml. and 211.8 mg. per 100 ml., but no significant differences were found between the mean values for α-cholesterol (49.9 mg. per 100 ml. for the policemen, 48.1 mg. per 100 ml. for the convicts), β cholesterol (174.9 mg. per 100 ml. for the policemen,

163.3 mg. per 100 ml. for the convicts) and the ratio of α-cholesterol in per cent of total cholesterol (23.3 per cent for the policemen, 23.6 per cent for the convicts).

Both groups included subjects with fairly stable lipid levels and others showing considerable variability. In the group of policemen the intra-individual standard deviation during the year of study was 17.8 mg. per 100 ml. for the total phospholipid values, 18.0 mg. per 100 ml. for the total cholesterol values, 5.2 mg. per 100 ml. for the α-cholesterol values, 18.6 mg. per 100 ml. for the β-cholesterol values and 2.5 per cent for the ratio of α-cholesterol to total cholesterol. In the group of convicts the intra-individual standard deviation was 19.3 mg. per 100 ml. for the total phospholipid values, 21.0 mg. per 100 ml. for the total cholesterol values (which is somewhat higher than in the group of policemen), 5.4 mg. per 100 ml. for the α-cholesterol values, 21.1 mg. per 100 ml. for the β-cholesterol values and 2.8 per cent for the ratio of α-cholesterol to total cholesterol.

The difference between two successive monthly total cholesterol determinations was over 50 mg. per 100 ml. at least once during the year of study in 35 per cent of the policemen and 44 per cent of the convicts. This difference never exceeded 30 mg. per 100 ml. in about 24 per cent of the policemen and in only 2 per cent of the convicts. The greatest difference between two successive individual cholesterol values was 86 mg. per 100 ml. in the group of policemen and 88 mg. per 100 ml. in the group of convicts.

In the lipid levels of the policemen no seasonal changes were observed. By contrast, in the group of convicts a seasonal trend was demonstrable in the values for total cholesterol, β-cholesterol and the ratio of α-cholesterol in per cent of total cholesterol, one cycle per year being discernible. In total cholesterol there was a minimum in May (187 mg. per 100 ml.) and a maximum in January (232 mg. per 100 ml.), in β-cholesterol there was a minimum in April (139 mg. per 100 ml.) and a maximum in January (176 mg. per 100 ml.), and the ratio of α-cholesterol in per cent of total cholesterol was lowest in December (21.2 per cent) and highest in April and June (25.2 per cent).

No correlation was observable between serum cholesterol and body weight or between serum cholesterol and relative body weight. In the group of policemen those showing the largest skinfold thickness had the highest cholesterol levels.

No significant seasonal changes in body weight were observed.

In connection with infections the values for total cholesterol dropped.

Various factors are discussed which might have influenced the changes in serum lipid concentration, but no explanation is found to the seasonal trend observable in the lipid values in the group of convicts. It appears, therefore, that it is a biological phenomenon, the sum of many factors, which is not strong enough to be clearly noticeable except under conditions where life is extremely regular, as it is in prison, and where external influences are slight. Under normal conditions, such as were present in the group of policemen, the factors influencing the lipid level are so many and so variable that the seasonal trend cannot manifest itself.

REFERENCES

Abell, L. L., Levy, B. B., Brodie, B. B., and Kendall, F. E.: A simplified method for the estimation of total cholesterol in serum and demonstration of its specificity. J. biol. Chem. 1952: *195*: 357.

Adlersberg, D., Schaefer, L. E., Steinberg, A. G., and Wang, C-I.: Age, sex, serum lipids, and coronary atherosclerosis. J. Amer. med. Ass. 1956: *162*: 619.

Ahrens, E. H., Jr., Blankenhorn, D. H., and Tsaltas, T. T.: Effect on human serum lipids of substituting plant for animal fat in diet. Proc. Soc. exp. Biol. (N.Y.) 1954: *86*: 872.

Ahrens, E. H., Jr., Hirsch, J., Insull, W., Tsaltas, T. T., Blomstrand, R., and Peterson, M. L.: The influence of dietary fats on serum lipid levels in man. Lancet 1957: *I*: 943.

Ahrens, E. H., Jr., Hirsch, J., Peterson, M. L., Insull, W., Jr., Stoffel, W., Farquhar, J. W., Miller, T., and Thomasson, H. J.: The effect on human serum-lipids of a dietary fat, highly unsaturated, but poor in essential fatty acids. Lancet 1959: *I*: 115.

Albanese, A. A., Higgons, R. A., Lorenze, E. J., and Orto, L. A.: Effect of dietary proteins on blood cholesterol levels of adults. Geriatrics 1959: *14*: 237.

Altschul, R., and Herman, I. H.: Ultraviolet irradiation and cholesterol metabolism. Circulation 1953: *8*: 438.

Altschul, R.: Ultraviolet irradiation and cholesterol metabolism. Arch. phys. Med. 1955: *36*: 394. (a)

Altschul, R.: Lowering of serum cholesterol by ultraviolet irradiation. Geriatrics 1955: *10*: 208. (b)

Altschul, R.: Einfluss von ultravioletter Bestrahlung auf Serumcholesterol. Strahlentherapie 1955: *97*: 461. (c)

Anderson, J. T., Lawler, A., Lowen, M., and Keys, A.: Changes in blood cholesterol during experimental overnutrition. Fed. Proc. 1952: *11*: 181.

Anderson, J. T., and Keys, A.: Cholesterol in serum and lipoprotein fractions. Its measurement and stability. Clin. Chem. 1956: *2*: 145. (a)

Anderson, J. T., Taylor, H. L., and Keys, A.: Serum cholesterol in subjects on reducing diets high and low in fat. Fed. Proc. 1956: *15*: 542. (b)

Anderson, J. T., Keys, A., and Grande, F.: The effects of different food fats on serum cholesterol concentration in man. J. Nutr. 1957: *62*: 421. (c)

Astrup, P.: On individual variations in serum cholesterol. Acta med. scand. 1948: *130*: 346.

Bazett, H. C.: The effect of heat on the blood volume and circulation. J. Amer. med. Ass. 1938: *111*: 1841.

Bazett, H. C., Sunderman, E. W., Doupe, J., and Scott, J. C.: Climatic effects on the volume and composition of blood in man. Am. J. Physiol. 1940: *129*: 69.

Barcroft, J., Binger, C. A., Book, A. V., Doggert, J. H., Forbes, H. S., Harrop, G., Meakins, J. C., and Redfield, A. C.: Observations upon the effect of high altitude on the physiological processes of the human body, carried out in the Peruvian Andes, chiefly at Cerro de Pasco. Phil. Tr. Roy. Soc., London, 1922: *221* B: 351.

Beischer, D. E.: Effect of simulated flight stresses on the concentration of serum cholesterol, phospholipids and lipoprotein. J. Aviat. Med. 1956: *27*: 260.

Bersohn, I., and Wayburne, S.: Serum cholesterol concentration in newborn African and European infants and their mothers. Am. J. clin. Nutr. 1956: *4*: 117.

Beveridge, J. M., Connell, W. F., and Mayer, G. A.: Dietary factors affecting the level of plasma cholesterol in humans: the role of fats. Canad. J. Biochem. Physiol. 1956: *34*: 441.

Beveridge, J. M. R., Connell, W. F., Mayer, G. A., and Haust, H. L.: Plant sterols, degree of unsaturation, and hypocholesterolemic action of certain fats. Canad. J. Biochem. Physiol. 1958: *36*: 895.

Bloomberg, B. M., Lazarus, F., Mrost, I., and Schneider, R.: Serum lipids in South African Bantu and white subjects. Circulation 1958: *17*: 1021.

Boyd, E. M.: Diurnal variations in plasma lipids. J. biol. Chem. 1935: *110*: 61.

Brock, J. F., and Bronte-Stewart, B.: Arteriosclerosis in African populations. Minnesota Med. 1955: *38*: 852.

Bronte-Stewart, B., Keys, A., and Brock, J. F.: Serum-cholesterol, diet, and coronary heart disease: An inter-racial survey in the Cape Peninsula. Lancet 1955: *II*: 1103.

Bronte-Stewart, B., Antonis, A., Eales, L., and Brock, J. F.: Effects of feeding different fats on serum-cholesterol level. Lancet 1956: *I*: 521.

Brožek, J.: Body measurements and human nutrition. Wayne University Press, Detroit, Michigan, 1956.

Bruger, M., and Somach, I.: The diurnal variations of the cholesterol content of the blood. J. biol. Chem. 1932: *97*: 23.

Bruger, M., and Pointdexter, C. A.: Relations of the plasma cholesterol to obesity and to some of the complicating degenerative diseases. Diabetes mellitus, essential hypertension, osteoarthritis and arteriosclerosis. Arch. intern. Med. 1934: *53*: 421.

Brun, G.: Changes in the lipid contents of serum in patients with manic-depressive psychosis. Acta psychiatr. neurol 1940: suppl. 22.

Brunner, D., and Lobl, K.: Serum-lipids in Israelic communities. Lancet 1957: *I*: 1300.

Caccialanza, P.: Esposizione solare della cute e colesterina ematica. Rass. Derm. Sif. 1959: *12*: 53.

Carlson, L. A.: Serum lipids in normal men. Acta med. scand. 1960: *167*: 377.

Chailley-Bert, Labignette, P., and Fabre-Chevalier: Contribution a l'étude des variations du cholestérol sanguin au cours des activités physiques. Presse méd. 1955: *63*: 415.

Chandler, H. L., Lawry, E. A., Potee, K. A., and Mann, G. V.: Spontaneous and induced variations in serum lipoproteins. Circulation 1953: *8*: 723.

Corsi, V., Giuliano, G., Marinoni, G. F., Rizza, O., and Pignataro, L.: Ricerche sulle variazioni in rapporto all'etá delle lipoproteine a del colesterola totale del siero in soggetti normali. Progr.Med. (Napoli) 1959: *15*: 661.

Currie, A. N.: The cholesterol of blood in malignant disease. Brit. J. exp. Path. 1924: *5*: 293.

Denis, W.: Cholesterol in human blood under pathological conditions. J. biol. Chem. 1917: *29*: 93.

Diven, R. H., Page, H. M., Erwin, E. S., and Roubicec, C. B.: Effect of environmental temperature on diurnal variation of blood constituents in the bovine. Amer. J. Physiol. 1958: *195*: 88.

Doupe, J., Ferguson, M. H., and Hildes, J. A.: Seasonal fluctuations in blood volume. Canad. J. Biochem. Physiol. 1957: *35*: 203.

Dreyfuss, F., and Czaczkes, J. W.: Blood cholesterol and uric acid of healthy medical students under the stress of an examination. A.M.A.Arch. intern. Med. 1959: *103*: 708.

Edholm, O. G.: Polar physiology. Fed. Proc. 1960: *19*: suppl. 5: 3.

Egsgaard, J.: Om lipoidstofskiftet ved psykoser. Undersøgelser over serumfosfatidernes forhold ved schizofreni, schizofrenilignende tilstande og stemningspsykoser. Nord. Med. 1943: *17*: 455.

Fahring, C., and Wacker, L.: Vergleichende Untersuchungen über den Lipoidkomplex des Blutserums bei essentieller Hypertension, Muskelarbeit, Hunger, Schwangerschaft und Nahrungsaufnahme. Klin. Wschr. 1932: *11*: 886.

Farquhar, J. W., Smith, R. E., and Dempsey, M. E.: The effect of β-sitosterol on the serum of young men with arteriosclerotic heart disease. Circulation 1956: *14*: 77.

Farquhar, J. W., and Sokolow, M.: Response of serum lipids and lipoproteins of man to beta-sitosterol and safflower oil. A long term study. Circulation 1958: *17*: 890.

Fiske, C. H., and Subbarow, Y.: The colorimetric determination of phosphorus. J. biol. Chem. 1925: *66*: 375.

Friedman, M., Rosenman, R. H., and Carroll, V.: Changes in the serum cholesterol and blood clotting time in man subjected to cyclic variation of occupational stress. Circulation 1958: *17*: 852.

Furman, R. H., Howard, R. P., and Norcia, L. N.: Influence of protein-free diet on concentration and lipoprotein distribution of serum cholesterol and phospholipid and their response to testosterone administration in human subjects. IIIrd World Congress of Cardiology, Brussels, Abstracts of communications, 1958, p. 573.

Gardner, J. A., and Gainsborough, H.: Studies on the cholesterol content of normal human plasma. Part III. On the so-called alimentary hypercholesterolaemia. Biochem. J. 1928: *22*: 1048.

Gertler, M. M., Garn, S. M., and Sprague, H. B.: Cholesterol, cholesterol esters and phospholipids in health and in coronary artery disease. II. Morphology and serum lipids in man. Circulation 1950: *2*: 380. (a)

Gertler, M. M., Garn, S. M., and Bland, E. F.: Age, serum cholesterol and coronary artery disease. Circulation 1950: *2*: 517. (b)

Gildea, E. F., Kahn, E., and Man, E. B.: The relationship between body build and serum lipoids and a discussion of these qualities as pyknophilic and leptophilic factors in the structure of the personality. Amer. J. Psychiatr. 1936: *92*: 1247.

Gofman, J. W., Jones, H. B., Lindgren, F. T., Lyon, T. P., Elliott, H. A., and Strisower, B.: Blood lipids and human atherosclerosis. Circulation 1950: *2*: 161.

Gofman, J. W., Hanig, M., Jones, H. B., Lauffer, M. A., Lawry, E. Y., Lewis, L. A., Mann, G. V., Moore, F. E., Olmsted, F., and Yeager, J. E.: Evaluation of serum lipoprotein and cholesterol measurements as predictors of clinical complications of atherosclerosis. Circulation 1956: *14*: 691.

Goldbloom, A. A.: Clinical studies of blood lipid metabolism. Amer. J. dig. Dis. 1952: *19*: 9.

Gordon, H., and Brock, J. F.: Studies on the regulation of the serum-cholesterol level in man. South Afr. med. J. 1958: *32*: 397.

Groen, J., Tjiong, B. K., Kamminga, C. E., and Willebrandts, A. F.: The influence of nutrition, individuality and some other factors including various forms of stress, on the serum cholesterol; an experiment of nine months duration in 60 normal human volunteers. Voeding 1952: *13*: 556.

Groover, M. E., Jr.: Clinical evaluation of a public health program to prevent coronary artery disease. Tr. and Stud., Coll. Phys. of Philadelphia 1957: 24: 105.

Groover, M. E., Jr., Jerrigan, J. A., and Martin, C. D.: Variations in serum lipid concentration and clinical coronary disease. Amer. J. med. Sci. 1960: *239*: 133.

Grundy, S. M., and Griffin, A. C.: Effects of periodic mental stress on serum cholesterol levels. Circulation 1959: *19*: 496.

Gupta, K. K., Iyer, P. V. K., and Nath, H. P.: Studies of serum cholesterol and lipid phosphorus in coronary heart disease. Metabolism 1958: 7: 349.

Hammarsten, J. F., Cathey, C. W., Redmond, R. F., and Stewart, W.: Serum cholesterol, diet and stress in patients with coronary artery disease. J. clin. Investig. 1957: *36*: 897.

Hodges, R. G., Sperry, W. M., and Andersen, D. H.: Serum cholesterol values for infants and children. Amer. J. Dis. Child. 1943: *65*: 858.

Härtel, G., and Aro, M.: Unpublished data.

Iakovlev, N. N.: Zhirovoi obmen pri dlitelńykh fizicheskikh magruzakh (Fat metabolism in prolonged physical stress). Fiziol. Ž. (Mosk.) 1952: *38*: 332.

Iakovlev, N. N., Iampol'skaia, L. I., Leshkevich, L. G., and Popova, N. K.: Biokhimicheskie izmeneniia v krovi u sportsmenov pri sorevnovaniiakh po sportivnym igram (Biochemical changes in blood in athletes, during competitive plays). Fiziol. Ž. (Mosk.) 1952: *38*: 739.

Jones, H. B., Gofman, J. W.:, Lindgren, F. T., Lyon, T. P., Graham, D. M., Strisower, B., and Nichols, A. V. Lipoproteins in atherosclerosis. Amer. J. Med. 1951: *11*: 358.

Josephson, B.: Om det kliniska värdet av kolesterinbestämning. Nord. Med. 1947: *33*: 498.

Josephson, B., and Dahlberg, G.: Variations in the cell-content and chemical composition of the human blood due to age, sex and season. Scand. J. clin. Lab. Invest. 1952: *4*: 216.

Josephson, B., Dahlberg, G., and Tötterman, G.: On the effect of nutrition upon the blood count and chemical composition of the blood. Scand. J. clin. Lab. Invest. 1952: *4*: 237.

Kaiser, A. D., and Gray, M. St.: Blood lipids in children with scarlet fever and rheumatic disease. Amer. J. Dis. Child. 1934: *47*: 9.

Kalliomäki, J. L., Waris, E. K., and Vasama, R.: Sitosterolernas verkan på blodets kolesterol och lipoproteiner. Nord. Med. 1957: *57*: 460.

Kartin, B. L., Man, E. B., Winkler, A. W., and Peters, J. P.: Blood ketones and serum lipids in starvation and water deprivation. J. clin. Invest. 1944: *23*: 824.

Karvonen, M. J., Rautanen, Y., Rikkonen, P., and Kihlberg, J.: Serum cholesterol of male and female champion skiers. Ann. Med. intern. Fenn. 1958: *47*: 75.

Karvonen, M. J., Orma, E., Keys, A., Fidanza, F., and Brožek, J.: Cicarette smoking, serum-cholesterol, blood pressure, and body fatness. Observations in Finland. Lancet 1959: *I*: 492.

Keys, A.: The physiology of the individual as an approach to more quantitative biology of man. Fed. Proc. 1949: *8*: 523.

Keys, A., Brožek, J., Henschel, A., Mickelsen, O., and Taylor, H. L.: The biology of human starvation. I. Univ. of Minnesota Press, Minneapolis 1950, p. 497. (a)

Keys, A., Mickelsen, O., Hayes, R., and Miller, E. v. O.: Age and serum cholesterol concentration in normal man. Fed. Proc. 1950: *9*: 69. (b)

Keys, A., Mickelsen, O., Miller, E. v. O., Hayes, E. R., and Todd, R. L.: The concentration of cholesterol in the blood serum of normal man and its relation to age. J. clin. Invest. 1950: *29*: 1347. (c)

Keys, A.: The age trend of serum concentration of cholesterol and of Sf 10—20 (»G») substances in adults. J. Gerontol. 1952: 7: 201.

Keys, A.: Obesity and degenerative heart disease. Amer. J. publ. Health 1954: *44*: 864.

Keys, A., Anderson, J. T., Fidanza, F., Keys, M. H., and Swahn, B.: Effect of diet on blood lipids in man. Particularly cholesterol and lipoproteins. Clin. Chem. 1955: *1*: 34. (a)

Keys, A., Anderson, J. T., and Michelsen, O.: Serum cholesterol in men in basal and nonbasal states. Science 1955: *123*: 29. (b)

Keys, A., Fidanza, F., and Keys, A.: Further studies on serum cholesterol of clinically healthy men in Italy. Voeding 1955: *16*: 492. (c)

Keys, A., Anderson, J. T., Aresu, M., Biörck, G., Brock, J. F., Bronte-Stewart, B., Fidanza, F., Keys, M. H., Malmros, H., Poppi, A., Posteli, T., Swahn, B., and del Vecchio, A.: Physical activity and the diet in populations differing in serum cholesterol. J. clin. Invest. 1956: *35*: 1173.

Keys, A., and Anderson, J. T.: Dietary protein and the serum cholesterol level in man. Amer. J. clin. Nutr. 1957: *5*: 29.

Keys, A., Karvonen, M. J., and Fidanza, F.: Serum-cholesterol studies in Finland. Lancet 1958: *II*: 175.

Keys, A., Anderson, J. T., and Grande, F.: Serum cholesterol in man: diet fat and intrinsic responsivenes. Circulation 1959: *19*: 201.

Keys, A., and Fidanza, F.: Serum cholesterol and relative body weight of coronary patients in different populations. Circulation 1960: *22*: 1091.

Kinsell, L. W., Michaels, G. D., Partridge, J. W., Bohling, A. L., Balch, H. E., and Cochrane, G. C.: Effects upon serum cholesterol and phospholipids of diets containing large amounts of vegetable fat. Amer. J. clin. Nutr. 1953: *I*: 224.

Kinsell, L. W., Michaels, G. D., Cochrane, G. C., Partridge, J. W., Jahn, J. P., and Balch, H. E.: Effect of vegetable fat on hypercholesterolemia and hyperphospholipidemia. Observations on diabetic and nondiabetic subjects given diets high in vegetable fat and protein. Diabetes 1954: *3*: 113.

Kipp, H. A.: Variation in the cholesterol content of the serum in pneumonia. J. biol. Chem. 1920: *44*: 215.

Konttinen, A.: Serum lipids in young men during military service. Ann. Med. exp. Biol. Fenniae 1959: *37*: suppl. 7.

Kornerup, V.: Concentrations of cholesterol, total fat and phospholipid in serum of normal man. Arch. intern. Med. 1950: *85*: 398.

Kuhl, W. J., Jr., Beck, E. M., Gershberg, H., Street, E., and Ralli, E. P.: Effect of cold water stress on blood and urine constituents on 55 normal male. Metabolism 1955: *4*: 143.

Larsen, N. P.: Diet and atherosclerosis. A.M.A. Arch. intern. Med. 1957: *100*: 436.

Laureus, H. J.: The physiologic effects of ultraviolet radiation. J. Amer. med. Ass. 1938: *111*: 2385.

Lavergne, V. de, and Kissel, P.: Essai d'interpretation des variations de la cholestérolémie au cours des infections aiguës. Presse méd. 1934: *42*: 393.

Levere, A. H., Bozian, R. C., Craft, G., Jackson, R. S., and Wilkinson, C. F.: The »sitosterols»: Variability of serum cholesterol levels and difficulty of evaluating decholesterolizing agents. Metabolism 1958: *7*: 338.

Lindholm, H.: Studies in normal adults for variation in serum lipids with sex, age, relative body-weight and with body-build. Scand. J. clin. Lab. Invest. 1956: *8*: suppl. 23.

Linko, E.: Vegetable oils and serum cholesterol. Short term experiments with rapeseed and sunflower seed oils. Acta med. scand. 1957: *159*: 475.

Loeper, M., and Degos, R.: Action des rayons ultra-violets sur la teneur en cholestérine du sérum. Bull. mém. Soc. Med. d. hǒp. de Paris 1930: *54*: 1458.

Luden, G.: Studies on cholesterol IV. Experiments concerning the relation of the diet, the blood cholesterol and the »lymphoid defence». J. Lab. clin. Med. 1917: *3*: 141.

Malczynski, S.: Influence de l'emploi de la lampe de quartz (systeme Hanau) sur le taux de la cholestérine dans le sang chez l'Homme et chez les animaux. C. R. Soc. Biol. (Paris) 1928: *99*: 922.

Malczynski, S.: Über den Einfluss der einmaligen Bestrahlung mittels Quarzlampe (System Hanau) auf den Cholesteringehalt im Blute der nichtkrebsigen und krebskranken Personen. Klin. Wschr. 1930: *9*: 936.

Malczynski, S., and Lankosz, J.: Le taux du cholestérol sanguin chez l'Homme immédiatement aprés l'irradiation unique par les rayons infra-rouges, les rayons solaires et les rayons limites. C. R. Soc. Biol. (Paris) 1933: *114*: 1126.

Malmros, H., and Wigand, G.: The effect on serum-cholesterol of diets containing different fats. Lancet 1957: *II*: 1.

Man, E. B., and Gildea, E. F.: Serum lipoids in malnutrition. J. clin. Invest. 1936: *15*: 203.

Man, E. B., and Gildea, E. F.: Variations in lipemia of normal subjects. J. biol. Chem. 1937: *119*: 769.

Man, E. B., and Peters, J. P. Variations of serum lipids with age. J. Lab. clin. Med. 1953: *41*: 738.

Mann, G. V., Munōz, J. A., and Scrimshaw, N. S.: The serum lipoprotein and cholesterol concentrations of Central and North Americans with different dietary habits. Amer. J. Med. 1955: *19*: 25. (a)

Mann, G. V., Teel, K., Hayes, O., McNally, A., and Bruno, D.: Exercise in the disposition of dietary calories. Regulation of serum lipoprotein and cholesterol levels in human subjects. New Engl. J. Med. 1955: *253*: 349. (b)

Marchioni, A., and Ottenstein, B.: Stoffwechselveränderungen im Schwitzbad bei Hautgesunden und Hautkranken. Klin. Wschr. 1931: *10*: 969.

Mathur, K. S., Wahl, P. N., Malhotra, K. K., Sharma, R. D., and Srivastava, S. K.: Dietary fats, serum cholesterol and serum lipid phosphorus in different sosio-economic groups in Uttar Pradesh. J. Ind. med. Ass. 1959: *33:* 303.

Maxfield, M. E., Bazett, H. C., and Chambers, C. C.: Seasonal and postural changes in blood volume determined by a carbon monoxide method, employing a differential electric photometer for the estimation of low percentage saturations of hemoglobin with carbon monoxide. Amer. J. Physiol. 1941: *133*: 128.

McClure, C. W., and Huntsinger, M. E.: Studies in fat metabolism. I. The influence on blood lipids of single foodstuffs. J. biol. Chem. 1928: *76*: 1.

McEachern, J. M., and Gilmour, C. R.: Studies in cholesterol metabolism. 1. Physiological variations in blood cholesterol. Canad. med. Ass. J. 1932: *26*: 30. (a)

McEachern, J. M., and Gilmour, C. R.: Studies in cholesterol metabolism. 2. Blood cholesterol in various conditions. Canad. med. Ass. J. 1932: *26*: 158. (b)

Metropolitan Life Insurance Company: Ideal weights for men. Statist. Bull. 1943: *24*: 6.

Miettinen, M.: Studies of serum lipids and lipoproteins in some anemias. Ann. Med. intern. Fenn. 1956: *45*: suppl. 22.

Milch, L. J., Taylor, W. F., Schlessinger, B. S., Hughes, H. M., Redmond, R. F., Weiner, N., Calhoun, W. W., and Yarnell, R. A.: Cardiovascular evaluation of West Point cadets: A four-year report. Milit. Med. 1958: *122*: 332.

Mjassnikow, A. L.: Beiträge zur Konstitutionsforschung: 2. Blutcholesteringehalt und Konstitution. Z. klin. Med. 1927: *105*: 228.

Mnukhina, E. S.: O potreblenii fosfatidov i kholesterina pri myshechnoi rabote (Phosphatide and cholesterol requirement in muscle work). Fiziol. Ž. (Mosk.) 1955: *41*: 89.

Montoye, H. J., Huss, W. D. van, Brewer, W. D., Jones, E. N., Ohlson, M. A., Mahoney, E., and Olson, H.: The effects of exercise on blood cholesterol in middle-aged men. Amer. J. clin. Nutr. 1959: *7*: 139.

Moore, N. S., Young, C. M., and Maynard, L. A.: Blood lipid levels as influenced by weight reduction in women. Amer. J. Med. 1954: *17*: 348.

Moore, N. S., Fryer, J. H., Young, C. M., and Maynard, L. A.: Blood lipid levels as influenced by weight reduction in men. Amer. J. clin. Nutr. 1955: *3*: 397.

Morrison, L. M., Gonzales, W. T., and Hall, L.: The significance of cholesterol variations in human blood serum. J. Lab. clin. Med. 1949: *34*: 1473.

Morrison, L. M.: The serum phospholipid-cholesterol ratio as a test for coronary atherosclerosis. J. Lab. clin. Med. 1952: *39*: 550.

Nichols, A. V., Dobbin, V., and Gofman, J. W.: Influence of dietary factors upon human serum lipoprotein concentrations. Geriatrics 1957: *12*: 7.

Nikkilä, E. A.: Studies on lipid-protein relationships in normal and pathological sera and the effect of heparin on serum lipoproteins. Scand. J. clin. Lab. Invest. 1953: 5: suppl. 8.

Nikkilä, E. A.: Atheromatose unter Berücksichtigung der Blutlipoide. Verhandl. Deutsch. Gesellsch. für Kreislaufforschung. 21. Tagung, Bad Nauheim, 1955: p. 65.

Nikkilä, E. A., and Niemi, T.: Serum lipids and lipoproteins in old age. Scand. J. clin. Lab. Invest. 1957: *9*: 109.

Nikkilä, E. A., and Jokipii, S. G.: Inverkan av essentiella fettsyror på serumlipoider hos åldringar. Nord. Med. 1959: *61*: 476.

Nishishita, S.: Studies on the fluctuation of the blood lipoid content in the fever period. Jap. J. exp. Med. 1941: *19*: 97. (ref. Wallis, A. D., and Viergiver, E.: Amer. J. med. Sci 1954: *227*: 176).

Olson, R. E., Vester, J. W., Gursey, D., Davis, N., and Longman, D.: The effect of low-protein diets upon serum cholesterol in man. Amer. J. clin. Nutr. 1958: *6*: 310.

Ott, V. R.: Die Sauna. Benno Schwabe & Co, Basel, 1948.

Padmavati, S., Gupta, S., and Pantulu, G. V. A.: Dietary fat, serum cholesterol levels and incidence of atherosclerosis in Delhi. Circulation 1959: *19*: 849.

Page, I. B.: Symposium on Triparanol (MER-29). Summary of clinical section II. Progr. cardiov. Dis. 1960: *II*: 646.

Paloheimo, J. A. I.: Unpublished data.

Paterson, J. C., and Derrick, J. B. D.: Comparison of total cholesterol levels in blood serum with lipid concentrations in human coronary arteries. Canad. J. Biochem. Physiol. 1957: *35*: 869.

Perkins, R., Wright, I. S., and Gatje, B. W.: Effect of safflower oil emulsion on serum cholesterol levels in young adult males. J. Amer. med. Ass. 1958: *166*: 2132.

Peters, J. P., and Man, E. B.: The interrelations of serum lipids in normal persons. J. clin. Inv. 1943: *22*: 707.

Petersen, W. F., and Levinson, S. A.: The skin reactions, blood chemistry and physical status of »normal» men and of clinical patients, Arch. Path. 1930: *9*: 151.

Peterson, J. E., Wilcox, A. A., Haley, M. I., and Keith, R. A.: Hourly variation in total serum cholesterol. Circulation 1960: *22*: 247.

Plavsic, C., Strasser, T., Milutinovic, P., and Nedvidek, B.: Über die Wirkung künstlicher und natürlicher UV-Bestrahlung auf die Cholesterinämie von arteriellen Hypertonikern. Arch. phys. Ther. (Lpz.) 1958: *10*: 463.

Pointdexter, C. A., and Bruger, M.: Effect of low caloric diets and resultant loss in weight on plasma cholesterol in the obese. Arch. intern. Med. 1935: *56*: 884.

Pollak, O. J.: Reduction of blood cholesterol in man. Circulation 1953: *7*: 702.

Pomeranze, J., Green, M. B., and Goldbloom, A.: Effect on serum lipids of 1) weight reduction without marked fat restriction, 2) rigid fat restriction without weight reduction. Bull. N.Y. Acad. Med. 1952: *28*: 611.

Pomeranze, J., Lucarello, R. J., and Goldbloom, A. A.: Obesity and serum lipids. Circulation 1953: *8*: 439.

Pucher, G. W., Griffith, F. R., Jr., Brownell, K. A., Klein, J. D., and Carmer, M. E.: Studies in human physiology. VI. Variations in blood chemistry over long periods of time, including those characteristic of menstruation. J. Nutr. 1934: 7: 169.

Rivin, A. U., Yoshino, J., Shickman, M., and Schjeide, O. A.: Serum cholesterol measurement — hazards in clinical interpretation. J. Amer. med. Ass. 1958: *166*: 2108.

Roine, P., Pekkarinen, M., Karvonen, M. J., and Kihlberg, J.: Diet and cardiovascular disease in Finland. Lancet 1958: *II*: 173.

Rosenman, R. H., and Friedman, M.: Change in the serum cholesterol and blood clotting time in men subjected to cyclic variation of emotional stress. Circulation 1957: *16*: 931.

Rosenman, R. H., and Friedman, M.: Observations on the effect of triparanol (MER-29) on the serum cholesterol of selected human subjects. Progr. cardiovasc. Dis. 1960: *II*: 605.

Ruskin, H., Cohn, T. D., Bloomberg, B. M., and Greenblatt, I. J.: Serum lipoprotein studies in the South African Bantu. Amer. J. med. Sci. 1958: *235*: 138.

Rudder, B., de: Grundriss einer Meteorobiologie des Menschen. Dritte Auflage, Berlin, 1952.

Schaefer, L. E., Adlersberg, D., and Steinberg, A. G.: Heredity, environment and serum cholesterol. Circulation 1958: *17*: 537. (a)

Schaefer, L. E., Adlersberg, D., and Steinberg, A. G.: Serum phospholipids. Genetic and environmental influences. Circulation 1958: *18*: 341. (b)

Schaefer, L. E., Steinberg, A. G., Adlersberg, D., and Ramirez, G.: Change of serum lipid levels with age: five year longitudinal study. Circulation 1960: *22*: 805.

Schube, P. G.: Variations in the blood cholesterol of man over a time period. J. Lab. clin. Med. 1936: *22*: 280.

Schlessinger, B. S.: Influences of exercise and diet on the blood lipids of a military population. Milit. Med. 1958: *123*: 274.

Scrimshaw, N. S., Trulson, M., Tejada, C., Hegsted, D. M., and Stare, F. J.: Serum lipoprotein and cholesterol concentrations. Comparison of rural Costa Rican, Guatemalan, and United States populations. Circulation 1957: *15*: 805.

Segall, S., and Neufeld, A. H.: Blood lipid variations in patients with hypercholesterolaemia and coronary artery disease. Canad. med. Ass. J. 1960: *83*: 521.

Seppä-Kivalo, A.: On seasonal variation in the galvanic excitability of infants in Finland. Ann. Paediatr. Fenniae 1954: *1*: suppl. 1.

Shapiro, W., Estes, E. H., Jr., and Hilderman, H. L.: Hourly variations in serum total cholesterol in normal males. Circulation 1957: *16*: 493.

Shapiro, W., Estes, E. H., Jr., and Hilderman, H. L.: Diurnal variability of serum cholesterol at normal and reduced levels. J. Lab. clin. Med. 1959: *54*: 213.

Sperry, W. M.: The relationship between total and free cholesterol in human blood serum. J. biol. Chem. 1936: *114*: 125.

Sperry, W. M.: The concentration of total cholesterol in the blood serum. J. biol. Chem. 1937: *117*: 391.

Sperry, W. M., and Webb, M.: The effect of increasing age on serum cholesterol concentration. J. biol. Chem. 1950: *187*: 107.

Steiner, A., and Turner, K. B.: Observations on the serum cholesterol in acute infections as recorded during and after pneumonia. J. clin. Invest. 1940: *19*: 373.

Steiner, A., and Domanski, B.: Serum cholesterol level in coronary arteriosclerosis. Arch. intern. Med. 1943: *71*: 397.

Stepp, W.: Über den Cholesteringehalt des Blutserums bei Krankheiten. Munch. med. Wschr. 1918: *65*: 781.

Stoesser, A. V., and McQuarrie, I.: Influence of acute infection and artificial fever on the plasma lipids. Amer. J. Dis. Child. 1935: *49*: 658.

Stoesser, A. V.: Altered lipid metabolism in acute infections of infants and of older children. Amer. J. Dis. Child. 1938: *56*: 1215.

Swahn, B.: Studies on blood lipids. Scand. J. clin. Lab. Invest. 1953: *5*: suppl. 9.

Tanner, J. M.: The relation between serum cholesterol and physique in healthy young men. J. Physiol. 1951: *115*: 371.

Taylor, H. L., Anderson, J. T., and Keys, A.: Diet, physical activity and serum cholesterol in man. Circulation 1957: *16*: 516. (a)

Taylor, H. L., Anderson, J. T., and Keys, A.: Physical activity, serum cholesterol and other lipids in man. Proc. Soc. exp. Biol. Med. (N.Y.) 1957: *95*: 383. (b)

Thannhauser, S. J.: Lipidoses. Third Ed., Grune & Stratton, New York and London, 1958.

Thomas, C. B., and Eisenberg, F. F.: Observations on the variability of total serum cholesterol in Johns Hopkins medical students. J. chron. Dis. 1957: *6*: 1.

Thomas, C. B., and Murphy, E.: Further studies on cholesterol levels in the Johns Hopkins medical students: the effect of stress at examinations. J. chron. Dis. 1958: *8*: 661.

Thomas, C. B., and Eisenberg, F. F.: Variability of cholesterol levels in individual Johns Hopkins medical students, with observations on stopping smoking, vitamin B12 administration and acute infection. Bull. Johns Hopk. Hosp. 1959: *105*: 14.

Thomas, C. B., and Garn: S. M.: Degree of obesity and serum cholesterol level. Science 1960: *131*: 42.

Thomas, C. B., Holljes, H. W. D., and Eisenberg, F. F.: Observations on seasonal variations in total serum cholesterol level among healthy young prisoners. Ann. intern. Med. 1961: *54*: 413.

Thompson, J. S., Abraham, A., Elias, A. V., and Scott, C. C.: Observations on the variation of total serum cholesterol levels in normal individuals and in patients with coronary heart disease. Amer. J. med. Sci. 1959: *237*: 319.

Toor, M., Katchalsky, A., Agmon, J., and Allalouf, D.: Serum-lipids and atherosclerosis among Yemenite immigrants in Israel. Lancet 1957: *I*: 1270.

Toor, M., Katchalsky, A., Agmon, J., and Allalouf, D.: Atherosclerosis and related factors in immigrants to Israel. Circulation 1960: *22*: 265.

Turner, K. B., and Steiner, A.: A long term study of the variations of serum cholesterol in man. J. clin. Invest. 1939: *18*: 45.

Turpeinen, O., Roine, P., Pekkarinen, M., Karvonen, M. J., Rautanen, Y., Runeberg, J., and Alivirta, P.: Effect on serum-cholesterol level of replacement of dietary milk fat by soybean oil. Lancet 1960: *I*: 196.

Villaverde, M., and Vidal, R.: Variacion estacional de la colesterinemia. Rev. med. cubana 1939: *50*: 760.

Walinski, F., and Bleisch, I.: Cholesteringehalt im Blut bei physikalischer Hyperthermie. Deutsche med. Wsch. 1939: *65*: 717.

Walker, W. J., and Wier, J. A.: Plasma cholesterol levels during rapid weight reduction. Circulation 1951: *3*: 864.

Walker, W. J.: Relationship of adiposity to serum cholesterol and lipoprotein levels and their modification by dietary means. Ann. intern. Med. 1953: *39*: 705.

Walker, W. J., Lawry, E. Y., Love, D. E., Mann, G. V., Levine, S. A., and Stare, F. J.: Effect of weight reduction and caloric balance on serum lipoprotein and cholesterol levels. Amer. J. Med. 1953: *14*: 654.

Walker, A. R. P., and Arvidsson, U. B.: Fat intake, serum cholesterol concentration, and atherosclerosis in the South African Bantu. Part I. Low fat intake and the age trend of serum cholesterol concentration in the South African Bantu. J. clin. Invest. 1954: *33*: 1358.

Walker, W. J., Weiner, N., and Milch, L. J.: Differential effect of dietary fat and weight reduction on serum levels of β-lipoproteins. Circulation 1957: *15*: 31.

Waris, E.: Studies on serum lipids and lipoproteins in hypertension. Acta med. scand. 1958: *161*: suppl. 337.

Watkin, D. M., Lawry, E. Y., Mann, G. V., and Halperin, M.: A study of serum β-lipoprotein and total cholesterol variability and its relation to age and serum level in adult human subjects. J. clin. Invest. 1954: *33*: 874.

Wertlake, P. T., Wilcox, A. A., Haley, M. I., and Peterson, J. E.: Relationship of mental and emotional stress to serum cholesterol levels. Proc. Soc. exp. Biol. Med. 1958: *97*: 163.

Whyte, H. M., Graham, I. A. D., and Wolfe, M. S.: Body fat, blood pressure and serum cholesterol of Australian men. Austr. Ann. Med. 1958: 7: 328.

Wiktor, Z., Jacyszyn, K., Paluszyńska, H., Szymańska, R., and Radzikowska, J.: Comparative studies on the plasma lipid levels in groups of different professions in Poland. Acta tertii Europaei de cordis scientia conventus Romae a.d. 1960: *II*: 35.

Wilkinson, C. F., Boyle, E., Jackson, R. S., and Benjamin, M. R.: Effect of varying the intake of dietary fat and the ingestion of sitosterol on lipid and lipoprotein fractions of human serum. Metabolism 1955: *4*: 302.

Yudkin, J.: Diet and coronary thrombosis. Lancet 1957: *II*: 155.

APPENDIX

Tables 10—24

TABLE 10

Individual Monthly Values of Serum Total Cholesterol (mg%) of Policemen and Convicts

Policemen

Subject	Feb. 1958	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan. 1959
2	245	244	235	218	216	—	221	231	226	239	203	198
3	204	264	221	229	238	—	251	279	250	237	207	241
4	122	167	164	135	145	—	171	156	173	164	150	158
5	317	319	236	304	288	—	259	317	318	320	328	328
6	311	336	336	312	313	260	279	286	273	303	294	350
7	215	236	224	262	224	—	219	193	231	208	216	211
8	181	197	189	185	188	173	—	197	185	195	200	185
9	131	158	—	145	—	154	129	151	156	170	141	160
10	202	186	210	217	—	181	195	199	195	182	213	210
11	192	182	176	160	167	170	168	161	172	183	171	147
12	224	287	289	261	250	275	251	255	267	294	277	278
16	199	205	168	192	175	—	167	165	182	210	210	180
19	190	203	199	217	209	192	—	238	260	205	—	202
20	216	167	155	214	184	177	179	182	—	198	206	211
21	215	237	157	185	171	—	190	183	202	199	183	186
26	238	238	207	214	—	212	222	247	204	216	227	211
27	270	217	220	254	226	—	255	256	258	261	264	236
28	210	205	186	175	186	—	191	200	182	193	167	178
29	201	192	176	—	—	190	177	204	190	188	167	199
30	261	236	236	244	222	257	—	—	265	265	242	251
32	195	210	232	224	208	221	—	234	202	215	247	230
33	341	324	286	277	258	277	—	326	328	310	314	285
35	212	217	181	200	183	182	182	—	208	215	193	199
38	252	230	233	254	279	—	276	288	267	291	248	253
39	256	220	220	215	—	195	214	208	210	—	198	210
40	248	248	231	249	221	208	—	248	—	221	218	222
42	249	261	200	247	218	226	222	—	228	239	230	224
43	178	173	132	—	169	151	169	154	180	176	175	181
44	280	254	262	225	206	222	238	—	240	228	230	243
46	307	329	256	295	270	270	234	266	—	362	295	331
47	277	294	264	280	—	276	276	295	298	264	270	244
48	224	292	230	270	234	237	287	—	266	249	254	237
50	177	202	187	172	—	192	185	201	222	221	188	199
51	174	189	180	176	179	—	171	189	—	—	176	190
52	320	271	276	326	278	265	351	354	356	296	330	286
53	196	209	154	177	181	—	152	169	195	187	—	170
55	182	200	182	183	187	190	205	193	—	193	—	193
56	203	195	173	187	173	—	213	—	183	199	187	191
58	246	225	243	215	210	—	225	220	235	238	220	234
59	269	264	227	254	242	233	240	233	217	199	220	231
60	255	257	259	236	231	265	209	257	278	268	238	267
61	317	339	299	297	235	303	280	279	318	289	305	271
62	327	325	254	294	294	299	249	—	276	287	303	310
63	210	236	225	221	214	201	210	207	193	186	208	204
70	145	161	129	143	144	—	156	148	159	153	142	137

Convicts

Subject	Feb. 1958	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan. 1959
201	210	208	169	187	221	234	216	247	241	219	213	232
203	286	274	242	227	266	255	235	239	256	247	232	262
205	202	208	208	177	174	209	227	204	206	201	199	209
206	234	224	215	255	216	218	234	216	242	282	274	255
207	165	185	159	140	160	177	165	187	178	155	154	170
208	286	245	256	257	290	322	281	286	297	284	275	317
209	171	190	158	180	166	177	188	160	202	167	180	214
210	200	191	177	158	170	171	192	189	203	174	156	187
213	246	275	256	261	311	270	292	348	287	294	276	318
215	162	216	145	—	166	137	136	138	149	136	144	—
216	163	163	159	150	136	190	166	197	193	135	158	198
217	156	180	141	169	161	149	159	177	167	163	158	168
218	318	308	240	266	296	290	286	281	294	301	274	318
219	287	264	246	254	266	284	256	258	250	256	245	—
220	199	221	184	193	207	208	225	226	224	196	212	225
221	231	217	194	223	202	233	205	231	206	234	254	251
223	190	213	179	186	165	194	180	191	199	195	187	221
224	214	222	181	171	200	173	187	221	188	189	197	242
225	204	231	216	224	232	211	183	204	207	216	229	261
227	173	160	140	146	151	113	166	149	204	176	220	210
228	254	276	188	191	215	238	280	281	—	210	—	260
229	198	188	179	—	155	212	193	211	192	209	231	279
230	190	167	170	194	160	167	—	162	164	180	191	219
231	267	278	240	230	229	—	252	259	—	236	217	275
232	211	218	187	162	187	183	166	162	198	187	213	220
233	207	244	226	221	205	221	215	226	228	256	208	238
234	199	244	246	213	220	205	222	233	228	211	252	240
235	168	161	138	154	149	151	153	181	193	195	215	183
236	174	191	204	200	183	179	180	161	232	221	216	221
238	256	208	258	227	211	271	254	294	267	246	242	289
239	222	244	215	272	262	251	240	263	—	—	244	301
240	182	158	170	165	173	121	181	189	207	207	216	212
242	198	191	175	171	175	160	167	177	184	179	190	210
244	197	218	206	186	183	221	216	230	244	256	220	265
245	193	193	184	171	200	184	216	201	218	207	205	244

TABLE 11

Age, Number of Determinations, Individual Mean Values and Standard Deviation of the Mean for Serum Lipids of Policemen and Convicts

Policemen

Subject	Age	No. of Determinations	Total Phospholipid mg %	Total Cholesterol mg %	α-Cholesterol mg %	β-Cholesterol mg %	α-Cholesterol per Cent
2	39	11	211.5 ± 13.58	225.1 ± 15.66	41.5 ± 3.36	183.5 ± 15.49	18.4 ± 1.84
3	34	11	248.7 ± 11.82	238.3 ± 22.73	41.9 ± 5.31	196.3 ± 20.73	17.6 ± 1.99
4	27	11	190.5 ± 13.13	155.0 ± 15.84	49.7 ± 7.78	116.1 ± 24.12	33.2 ± 5.66
5	28	11	284.6 ± 19.94	303.1 ± 30.10	41.5 ± 4.92	260.6 ± 27.35	13.7 ± 1.52
6	35	12	313.1 ± 35.81	304.4 ± 27.47	58.2 ± 6.10	246.1 ± 29.43	19.3 ± 3.03
7	29	11	243.5 ± 25.56	221.7 ± 17.71	56.9 ± 3.73	164.7 ± 16.77	25.7 ± 1.96
8	28	11	207.0 ± 7.44	188.6 ± 8.08	50.7 ± 2.65	137.8 ± 7.84	26.9 ± 1.56
9	26	10	177.3 ± 7.26	149.5 ± 13.01	44.8 ± 6.00	114.6 ± 27.55	29.6 ± 2.26
10	29	11	226.6 ± 15.86	199.1 ± 12.59	66.4 ± 8.38	132.6 ± 12.01	33.4 ± 4.02
11	35	12	195.9 ± 12.91	170.8 ± 11.89	45.9 ± 4.84	124.8 ± 12.02	26.9 ± 3.03
12	33	12	276.7 ± 17.71	267.3 ± 20.16	42.1 ± 3.65	225.1 ± 18.69	15.7 ± 1.29
16	31	11	213.8 ± 10.54	186.6 ± 17.36	51.4 ± 8.03	135.2 ± 15.43	28.0 ± 3.00
19	38	10	231.9 ± 11.95	211.5 ± 21.85	50.9 ± 6.07	161.7 ± 19.16	24.1 ± 2.45
20	29	11	216.3 ± 19.99	189.9 ± 20.39	49.4 ± 3.44	140.4 ± 21.31	26.3 ± 4.01
21	26	11	201.5 ± 13.58	191.6 ± 21.49	46.5 ± 5.77	145.0 ± 17.26	24.3 ± 1.91
26	33	11	225.9 ± 15.96	221.5 ± 14.24	47.8 ± 4.99	173.6 ± 13.22	22.0 ± 2.68
27	33	11	261.9 ± 17.08	247.0 ± 18.76	38.6 ± 1.37	208.3 ± 19.24	15.7 ± 1.55
28	33	11	204.3 ± 9.66	188.9 ± 13.31	41.2 ± 4.28	147.6 ± 12.78	21.8 ± 2.47
29	29	10	228.0 ± 15.43	188.4 ± 11.90	50.9 ± 6.88	137.3 ± 12.86	27.0 ± 3.85
30	42	10	261.8 ± 24.56	247.9 ± 14.35	60.1 ± 3.46	187.7 ± 13.87	24.3 ± 1.84
32	41	11	261.5 ± 20.32	219.8 ± 15.50	53.8 ± 6.05	165.9 ± 11.46	24.4 ± 1.71
33	38	11	297.0 ± 29.02	302.4 ± 26.82	44.9 ± 4.17	257.4 ± 26.58	14.9 ± 1.72
35	26	11	209.4 ± 11.28	197.9 ± 14.06	60.5 ± 5.80	137.3 ± 15.75	30.7 ± 4.04
38	37	11	252.8 ± 15.51	261.0 ± 20.79	44.2 ± 6.28	216.7 ± 19.49	16.9 ± 2.55
39	36	10	231.5 ± 14.90	214.6 ± 16.73	45.5 ± 4.20	169.0 ± 15.23	21.2 ± 1.92
40	37	10	259.3 ± 16.98	231.4 ± 15.52	53.9 ± 4.68	177.3 ± 14.28	23.4 ± 1.93
42	40	11	238.6 ± 22.26	231.3 ± 16.82	43.7 ± 3.45	187.5 ± 16.04	18.9 ± 1.67
43	30	11	198.5 ± 15.78	167.1 ± 15.25	45.1 ± 5.50	131.0 ± 23.03	28.1 ± 1.98
44	26	11	246.2 ± 25.12	238.9 ± 20.56	46.3 ± 4.10	192.5 ± 21.87	19.5 ± 2.80
46	30	11	305.3 ± 35.16	292.3 ± 37.86	42.5 ± 6.26	249.6 ± 23.20	14.8 ± 2.95
47	36	11	259.0 ± 14.18	276.2 ± 15.92	42.2 ± 4.89	237.5 ± 10.38	15.3 ± 1.61
48	33	11	264.3 ± 20.20	252.7 ± 23.22	64.9 ± 10.42	187.7 ± 21.65	25.7 ± 3.94
50	26	11	230.0 ± 16.46	195.1 ± 16.07	52.5 ± 4.58	142.5 ± 14.62	26.9 ± 2.34
51	33	9	230.6 ± 9.89	180.4 ± 7.16	52.0 ± 3.13	128.4 ± 9.42	28.8 ± 2.55
52	35	12	319.0 ± 39.17	309.1 ± 34.35	41.9 ± 6.53	267.1 ± 36.86	13.7 ± 3.00
53	29	10	220.1 ± 27.65	179.0 ± 18.41	56.1 ± 10.78	111.6 ± 39.49	31.2 ± 4.54
55	45	10	222.0 ± 8.51	191.3 ± 8.00	59.9 ± 3.09	131.3 ± 545	31.3 ± 0.78
56	25	10	201.8 ± 16.28	190.4 ± 12.68	43.8 ± 2.87	146.5 ± 11.58	23.0 ± 1.60
58	43	11	233.2 ± 14.39	228.3 ± 11.71	66.5 ± 6.19	161.6 ± 10.44	29.6 ± 2.09
59	28	12	264.8 ± 25.01	235.8 ± 19.90	63.5 ± 5.65	172.2 ± 17.06	27.2 ± 2.41
60	35	12	253.9 ± 14.84	251.7 ± 19.48	51.6 ± 4.15	199.9 ± 18.99	20.6 ± 2.07
61	45	12	303.3 ± 21.75	294.3 ± 26.66	38.3 ± 5.40	247.6 ± 33.99	13.1 ± 2.11
62	33	11	278.3 ± 20.48	292.5 ± 25.27	45.8 ± 4.50	246.6 ± 23.84	15.6 ± 1.72
63	41	12	223.6 ± 17.28	209.6 ± 13.59	57.5 ± 5.56	165.1 ± 28.81	25.2 ± 3.03
70	33	11	186.3 ± 10.13	147.0 ± 9.67	48.9 ± 4.07	98.1 ± 10.79	33.4 ± 3.63

Convicts

Subject	Age	No. of Determinations	Total Phospholipid mg %	Total Cholesterol mg %	α-Cholesterol mg %	β-Cholesterol mg %	α-Cholesterol per Cent
201	23	12	231.2 ± 17.42	216.4 ± 22.07	29.6 ± 2.99	186.7 ± 21.44	13.8 ± 1.82
203	42	12	265.5 ± 23.93	251.8 ± 18.01	43.0 ± 5.25	208.6 ± 17.02	17.1 ± 2.00
205	46	12	221.2 ± 21.19	202.0 ± 14.25	59.9 ± 5.22	142.1 ± 12.43	29.7 ± 2.60
206	28	12	250.5 ± 30.84	238.8 ± 23.25	54.5 ± 7.24	184.1 ± 18.73	22.8 ± 2.16
207	27	12	202.2 ± 13.55	166.2 ± 13.26	45.1 ± 4.91	121.0 ± 12.29	27.3 ± 2.73
208	49	12	270.2 ± 14.85	283.0 ± 23.08	51.7 ± 8.52	231.1 ± 27.05	17.9 ± 2.89
209	23	12	207.8 ± 17.70	179.4 ± 16.89	52.3 ± 4.30	127.0 ± 14.76	29.2 ± 2.51
210	33	12	203.3 ± 20.24	180.7 ± 15.39	49.8 ± 4.36	139.1 ± 34.74	27.6 ± 2.17
213	36	12	266.5 ± 27.49	286.2 ± 28.91	46.0 ± 4.33	240.0 ± 27.24	16.1 ± 1.66
215	32	10	202.9 ± 27.81	152.9 ± 24.58	60.4 ± 6.49	92.4 ± 21.03	39.9 ± 4.10
216	31	12	183.6 ± 15.28	167.3 ± 22.40	34.1 ± 5.03	133.1 ± 18.75	20.4 ± 1.93
217	25	12	185.3 ± 11.77	162.3 ± 11.00	45.2 ± 4.19	117.1 ± 9.86	27.9 ± 2.43
218	47	12	281.4 ± 12.00	289.3 ± 22.34	56.0 ± 5.28	233.2 ± 19.59	19.4 ± 1.56
219	44	11	259.9 ± 9.30	260.5 ± 13.95	43.4 ± 4.84	219.8 ± 16.45	16.7 ± 1.96
220	25	12	213.6 ± 22.48	210.0 ± 14.53	42.8 ± 3.92	167.2 ± 14.06	20.4 ± 2.05
221	40	12	250.2 ± 14.22	223.4 ± 21.37	54.0 ± 6.66	165.1 ± 15.71	24.2 ± 2.79
223	29	12	222.6 ± 22.00	191.7 ± 14.93	56.9 ± 5.80	134.7 ± 11.64	29.6 ± 2.13
224	30	12	227.9 ± 27.83	198.8 ± 21.83	46.5 ± 6.02	151.9 ± 21.85	23.7 ± 3.62
225	33	12	220.8 ± 13.32	218.2 ± 19.46	43.6 ± 2.99	174.4 ± 18.56	20.1 ± 1.94
227	39	12	212.4 ± 30.37	167.3 ± 31.42	47.5 ± 6.34	119.7 ± 29.64	30.1 ± 5.07
228	33	10	250.0 ± 31.36	239.3 ± 36.21	55.7 ± 8.71	183.5 ± 33.85	23.6 ± 4.39
229	31	11	219.5 ± 21.49	204.3 ± 31.74	39.2 ± 13.60	161.4 ± 28.99	21.1 ± 3.04
230	22	11	198.6 ± 17.15	178.5 ± 18.26	45.8 ± 3.07	132.7 ± 17.66	25.8 ± 2.56
231	37	10	252.3 ± 22.70	248.3 ± 21.03	56.0 ± 9.71	182.2 ± 31.20	22.7 ± 3.66
232	32	12	205.2 ± 20.46	191.2 ± 21.15	54.6 ± 6.16	138.1 ± 19.35	28.8 ± 2.21
233	27	12	231.3 ± 18.32	224.6 ± 15.51	46.1 ± 4.62	178.4 ± 14.61	20.6 ± 2.13
234	46	12	239.0 ± 14.85	226.1 ± 17.23	48.6 ± 3.83	177.4 ± 14.69	21.5 ± 1.21
235	28	12	197.3 ± 19.37	170.1 ± 23.21	41.3 ± 4.32	128.7 ± 25.65	24.8 ± 4.79
236	33	12	203.3 ± 16.03	196.8 ± 22.29	49.8 ± 5.98	146.9 ± 19.68	25.3 ± 3.05
238	31	12	228.9 ± 15.53	251.9 ± 27.22	38.2 ± 4.59	213.6 ± 26.07	15.4 ± 2.16
239	32	10	257.3 ± 20.00	251.4 ± 24.86	43.2 ± 4.07	199.1 ± 37.51	17.3 ± 2.72
240	42	12	211.2 ± 19.54	181.8 ± 27.25	47.0 ± 4.81	134.7 ± 27.24	26.4 ± 4.88
242	37	12	191.6 ± 11.81	181.4 ± 13.97	47.3 ± 4.11	134.0 ± 13.15	26.1 ± 2.50
244	26	12	238.1 ± 21.92	220.2 ± 25.70	56.7 ± 3.98	163.4 ± 27.16	26.3 ± 4.02
245	31	12	210.7 ± 10.21	201.3 ± 19.12	49.2 ± 4.31	152.0 ± 18.94	24.6 ± 2.95

TABLE 12

Height, Weight, Relative Body Weight, Arm and Subscapular Skinfold Sum, Biacromial Diameter and Bicristal Diameter of Policemen and Convicts: Quartiles and Semi-interquartile Range

	D	Q1	Q2 (Median)	Q3
Height (cm)				
Policemen	7	175	180	189
Convicts	4	169	173	178
Weight (kg)				
Policemen	4	74	78	83
Convicts	4	64	67	71
Relative Body Weight				
Policemen	0.08	0.97	1.06	1.13
Convicts	0.06	0.93	0.98	1.05
Skinfold Sum (mm)				
Policemen	6	18	24	29
Convicts	4	13	17	21
Biacromial Diameter (cm)				
Policemen	1.3	38.4	39.5	41.0
Convicts	1.6	36.7	37.9	39.8
Bicristal Diameter (cm)				
Policemen	0.8	28.9	29.8	30.6
Convicts	0.9	27.8	28.9	29.6

TABLE 13

Cumulative Per Cent Distribution of Height, Weight, Relative Body Weight, Arm and Subscapular Skinfold Sum, Biacromial and Bicristal Diameter of Policemen and Convicts

Height (cm)	≦ 160	≦ 165	≦ 170	≦ 175	≦ 180	≦ 185	≦ 186 or over
Policemen	—	—	2	27	47	84	100
Convicts	3	3	31	60	86	97	100
Weight (kg)	≦ 65	≦ 70	≦ 75	≦ 80	≦ 85	≦ 85.5 or over	
Policemen	4	11	31	62	82	100	
Convicts	31	71	86	97	97	100	
Relative Body Weight	≦ 90	≦ 0.95	≦ 1.06	≦ 1.05	≦ 1.10	≦ 1.15	≦ 1.16 or over
Policemen	4	18	33	44	67	80	100
Convicts	17	31	63	74	91	100	100
Skinfold Sum (mm)	≦ 15	≦ 20	≦ 25	≦ 30	≦ 30.5 or over		
Policemen	9	33	53	82	100		
Convicts	38	73	85	94	100		
Biacromial Diameter (cm)	≦ 34	≦ 36	≦ 38	≦ 40	≦ 42	≦ 42.1 or over	
Policemen	2	2	16	60	91	100	
Convicts	3	9	53	77	94	100	
Bicristal Diameter (cm)	≦ 27	≦ 28	≦ 29	≦ 30	≦ 31	≦ 32	≦ 32.1 or over
Policemen	4	11	27	56	87	98	100
Convicts	3	29	53	91	91	97	100

TABLE 14

Monthly Total Phospholipid Levels of Policemen and Convicts: Quartiles, Semi-interquartile Range, Moving Averages and Predicted Seasonal Values

	Q1	Q2 (Median)	Q3	D	A	C
Policemen						
Feb. 1958	214	237	273	30	239	236
March	215	246	281	33	237	237
April	209	228	258	24	238	238
May	213	241	278	32	233	238
June	201	230	253	26	237	237
July	208	241	266	29	235	236
Aug.	213	235	258	22	237	235
Sept.	208	235	262	27	235	234
Oct.	209	236	266	28	232	233
Nov.	207	226	264	28	231	232
Dec.	206	232	267	30	230	233
Jan. 1959	209	234	260	26	234	234
Convicts						
Feb. 1958	207	222	252	22	233	228
March	215	239	265	25	224	224
April	191	211	241	25	221	219
May	194	215	240	23	208	214
June	185	199	232	24	209	212
July	192	215	244	26	213	212
Aug.	199	226	243	22	219	214
Sept.	199	218	258	30	223	218
Oct.	204	226	254	25	220	224
Nov.	204	218	251	24	222	228
Dec.	207	224	251	22	227	230
Jan. 1959	216	240	263	24	228	230

TABLE 15

Monthly Total Cholesterol Levels of Policemen and Convicts: Quartiles, Semi-interquartile Range, Moving Averages and Predicted Seasonal Values

	Q1	Q2 (Median)	Q3	D	A	C
Policemen						
Feb. 1958	195	219	265	35	220	217
March	197	226	265	34	217	216
April	181	208	246	32	216	214
May	186	216	262	38	211	213
June	183	209	238	28	211	212
July	180	208	253	36	210	213
Aug.	185	215	255	35	215	215
Sept.	185	223	262	38	220	216
Oct.	190	223	263	36	220	218
Nov.	189	215	259	35	217	219
Dec.	186	215	249	32	215	220
Jan. 1959	188	215	249	30	216	219
Convicts						
Feb. 1958	177	199	236	30	213	209
March	187	210	239	26	200	202
April	168	193	226	29	196	196
May.	164	187	228	32	191	193
June	164	193	223	30	194	194
July	173	204	239	33	199	197
Aug.	174	201	239	32	206	204
Sept.	184	215	247	32	211	211
Oct.	193	218	242	24	214	217
Nov.	184	210	241	28	214	220
Dec.	191	215	240	24	219	219
Jan. 1959	206	232	266	30	215	216

TABLE 16

Monthly α-Cholesterol Levels of Policemen and Convicts: Quartiles, Semi-interquartile Range, Moving Averages and Predicted Seasonal Values

	Q1	Q2 (Median)	Q3	D	A
Policemen					
Feb. 1958	43	48	54	6	49.0
March	44	49	54	5	48.0
April	42	47	51	6	48.3
May	43	49	56	6	48.3
June	43	49	54	6	49.0
July	43	49	55	6	48.6
Aug.	42	48	56	7	47.6
Sept.	42	46	53	6	48.0
Oct.	43	50	55	6	48.3
Nov.	42	49	54	6	49.6
Dec.	42	50	54	6	49.6
Jan. 1959	44	50	55	6	49.3
Convicts					
Feb. 1958	44	50	60	8	49.6
March	43	51	55	6	50.3
April	44	50	56	6	48.6
May	42	45	53	6	48.0
June	46	49	54	4	45.6
July	40	43	49	4	47.0
Aug.	45	49	52	4	47.0
Sept.	43	49	50	4	49.0
Oct.	45	49	54	4	47.6
Nov.	40	45	50	5	46.3
Dec.	39	45	51	6	46.0
Jan. 1959	44	48	54	5	47.6

TABLE 17

Monthly β-Cholesterol Levels of Policemen and Convicts: Quartiles, Semi-interquartile Range and Moving Averages

	Q1	Q2 (Median)	Q3	D	A	C
Policemen						
Feb. 1958	151	177	220	34	173	171
March	144	183	217	36	174	170
April	135	164	194	30	171	169
May	138	168	206	34	163	167
June	131	157	186	28	162	165
July	131	161	207	38	161	164
Aug.	135	166	203	34	166	164
Sept.	136	171	216	40	168	164
Oct.	138	168	212	37	167	166
Nov.	145	167	217	36	165	168
Dec.	138	165	198	30	163	170
Jan. 1959	136	161	198	31	166	171
Convicts						
Feb. 1958	127	158	191	32	164	161
March	137	158	191	27	152	154
April	115	139	177	31	147	147
May	124	144	181	28	142	144
June	115	143	178	32	147	144
July	130	155	195	32	150	148
Aug.	129	151	191	31	157	155
Sept.	134	165	203	34	161	162
Oct.	141	168	197	28	166	168
Nov.	139	165	201	31	168	172
Dec.	144	171	198	26	170	172
Jan. 1959	152	176	213	30	168	168

TABLE 18

Monthly α-Cholesterol in Per Cent of Total Cholesterol of Policemen and and Convicts: Quartiles, Semi-interquartile Range, Moving Averages and Predicted Seasonal Values

	Q1.	Q2 (Median)	Q3	D	A	C
Policemen						
Feb. 1958	17.4	21.9	27.3	5.0	22.6	22.9
March	17.0	22.3	27.2	5.1	22.6	23.2
April	19.1	23.6	28.9	4.9	23.1	23.4
May	19.0	23.6	28.3	4.6	23.8	23.6
June	19.5	24.4	29.1	4.8	24.0	23.7
July	18.3	24.2	28.8	5.2	23.9	23.6
Aug.	18.0	23.2	28.4	5.2	23.0	23.3
Sept.	16.9	21.8	27.0	5.0	22.5	23.0
Oct.	17.0	22.7	27.8	5.4	22.4	22.8
Nov.	16.6	22.9	27.6	5.5	22.8	22.6
Dec.	17.4	23.0	28.3	5.4	23.2	22.5
Jan. 1959	18.3	23.7	28.6	5.2	22.8	22.6
Convicts						
Feb. 1958	19.8	24.8	29.6	4.9	23.3	23.3
March	18.9	23.7	28.3	4.7	24.5	24.1
April	21.6	25.2	30.9	4.6	24.4	24.8
May	19.8	24.3	29.0	4.6	24.9	25.1
June	19.9	25.2	30.2	5.2	24.2	24.9
July	18.5	23.3	28.3	4.9	24.3	24.2
Aug.	20.3	24.4	27.8	3.8	23.2	23.3
Sept.	17.9	22.0	26.2	4.2	22.9	22.5
Oct.	18.2	22.5	26.9	4.2	21.9	21.8
Nov.	17.2	21.3	24.7	3.8	21.6	21.5
Dec.	17.2	21.2	25.2	4.0	21.3	21.7
Jan. 1959	17.4	21.6	24.8	3.7	22.5	22.4

TABLE 19

Monthly Weights of Policemen and Convicts: Quartiles and Semi-interquartile Range and Moving Averages

	Q1	Q2 (Median)	Q3	D	A
Policemen					
Feb. 1958	73.3	79.2	83.8	5.2	78.9
March	73.6	78.8	82.9	4.6	79.1
April	73.3	79.2	83.5	5.1	78.9
May	73.9	78.6	82.9	4.5	78.8
June	74.3	78.5	83.1	4.4	78.5
July	73.3	78.3	83.1	4.9	78.5
Aug.	73.8	78.6	83.5	4.8	78.3
Sept.	73.6	78.1	83.0	4.7	78.3
Oct.	73.3	78.1	83.0	4.8	78.0
Nov.	73.3	77.9	83.4	5.0	78.0
Dec.	73.3	78.1	83.0	4.8	78.2
Jan. 1959	73.9	78.6	83.3	4.7	78.6
Convicts					
Feb. 1958	64.3	67.6	71.8	3.8	68.1
March	64.3	68.7	73.1	4.4	68.1
April	64.3	68.1	72.6	4.2	68.0
May	64.3	67.2	69.8	2.8	67.5
June	63.7	67.3	71.8	4.0	67.0
July	63.4	66.5	69.4	3.0	66.8
Aug.	63.4	66.5	69.4	3.0	66.4
Sept.	63.1	66.2	69.4	3.2	66.5
Oct.	63.1	66.7	71.8	4.4	66.8
Nov.	63.7	67.5	72.0	4.2	67.4
Dec.	64.3	68.1	72.1	3.9	67.6
Jan. 1959	63.7	68.1	72.6	4.4	67.6

TABLE 20

Cumulative Per Cent Distribution of Total Phospholipid Values of Policemen and Convicts

Total Phospholipid	≦175	≦200	≦225	≦250	≦275	≦300	≦301 or over
Policemen							
Feb. 1958	—	7	38	62	76	87	100
March	2	13	33	53	71	89	100
April	4	13	47	69	87	98	100
May	4	13	36	58	73	89	100
June	2	24	44	73	89	96	100
July	—	20	36	58	84	93	100
Aug.	2	11	38	69	87	96	100
Sept.	—	18	40	64	87	96	100
Oct.	2	16	40	62	82	91	100
Nov.	—	16	49	69	80	91	100
Dec.	—	20	42	69	78	91	100
Jan. 1959	2	16	40	69	84	93	100
Convicts							
Feb. 1958	3	14	54	74	89	97	100
March	—	11	34	63	83	97	100
April	3	37	66	80	97	100	100
May	6	31	63	83	97	100	100
June	9	51	71	86	94	97	100
July	6	34	60	80	97	100	100
Aug.	—	26	49	86	94	100	100
Sept.	—	26	60	69	89	97	100
Oct.	—	20	49	71	94	100	100
Nov.	3	17	63	74	94	97	100
Dec.	3	14	51	74	91	100	100
Jan. 1959	—	9	34	60	89	100	100

TABLE 21

Cumulative Per Cent Distribution of Total Cholesterol Values of Policemen and Convicts

Total Cholesterol	≦ 150	≦ 175	≦ 200	≦ 225	≦ 250	≦ 275	≦ 300	≦ 301 or over
Policemen								
Feb. 1958	7	9	29	56	67	80	84	100
March	—	11	27	49	67	80	87	100
April	4	20	42	58	78	89	98	100
May	9	16	36	58	69	82	93	100
June	7	18	40	67	82	87	98	100
July	2	20	44	62	73	89	98	100
Aug.	2	18	36	60	73	84	96	100
Sept.	2	16	38	51	69	82	93	100
Oct.	—	9	36	51	67	82	89	100
Nov.	—	7	38	58	71	82	91	100
Dec.	7	16	36	60	76	82	89	100
Jan. 1959	4	11	38	58	76	84	91	100
Convicts								
Feb. 1958	—	23	51	71	80	89	97	100
March	—	14	37	69	80	91	97	100
April	11	31	57	74	91	100	100	100
May	9	37	63	74	83	100	100	100
June	6	40	54	77	83	91	97	100
July	11	26	46	69	80	91	97	100
Aug.	3	26	49	69	80	89	100	100
Sept.	6	17	40	57	77	86	97	100
Oct.	3	9	31	57	83	91	100	100
Nov.	6	17	40	66	80	89	97	100
Dec.	3	14	31	63	83	97	100	100
Jan. 1959	—	9	17	46	60	83	89	100

TABLE 22

Cumulative Per Cent Distribution of α-Cholesterol Values of Policemen and Convicts

α-Cholesterol	≦30	≦35	≦40	≦45	≦50	≦55	≦60	≦65	≦65.1 or over
Policemen									
Feb. 1958	—	4	9	33	62	78	87	100	
March	—	—	9	31	58	78	84	100	
April	—	2	11	42	62	71	82	100	
May	2	2	11	36	56	71	87	100	
June	—	—	16	29	56	78	84	100	
July	—	—	9	36	56	76	82	100	
Aug.	—	—	13	40	56	73	84	100	
Sept.	—	2	18	44	67	80	89	100	
Oct.	—	2	11	36	51	76	89	100	
Nov.	2	4	13	40	58	80	87	100	
Dec.	—	4	20	33	49	78	84	100	
Jan. 1959	—	—	11	31	51	76	84	100	
Convicts									
Feb. 1958	—	3	14	29	51	63	74	89	100
March	—	9	14	34	43	74	83	94	100
April	—	3	6	31	49	71	86	97	100
May	6	9	11	54	71	77	97	97	100
June	3	6	11	20	57	80	89	94	100
July	—	6	23	63	77	86	94	97	100
Aug.	3	6	9	26	66	86	94	97	100
Sept.	3	3	9	37	74	100	100	100	100
Oct.	—	6	11	26	57	80	94	100	100
Nov.	6	11	26	49	77	83	94	97	100
Dec.	3	6	29	51	71	94	94	97	100
Jan. 1959	—	3	11	31	60	80	89	100	100

TABLE 23

Cumulative Per Cent Distribution of β-Cholesterol Values of Policemen and Convicts

β-Cholesterol	≦ 100	≦ 125	≦ 150	≦ 175	≦ 200	≦ 225	≦ 250	≦ 251 or over
Policemen								
Feb. 1958	2	9	24	49	64	78	87	100
March	—	7	31	44	64	80	84	100
April	4	16	38	60	80	91	96	100
May	4	13	36	56	73	82	89	100
June	2	20	42	71	80	84	96	100
July	—	20	40	62	73	80	98	100
Aug.	2	18	36	58	73	89	96	100
Sept.	—	16	36	53	62	82	91	100
Oct.	—	13	36	56	67	84	89	100
Nov.	—	9	29	60	69	78	84	100
Dec.	4	13	36	60	76	78	89	100
Jan. 1959	2	13	40	62	76	80	91	100
Convicts								
Feb. 1958	3	23	43	66	80	89	97	100
March	—	9	43	66	80	91	97	100
April	11	34	63	74	89	100	100	100
May	9	26	57	71	89	100	100	100
June	3	40	54	74	83	89	97	100
July	9	20	46	66	77	86	97	100
Aug.	3	20	49	66	80	91	100	100
Sept.	3	17	40	57	74	83	94	100
Oct.	3	14	31	57	77	91	100	100
Nov.	3	14	34	60	74	91	100	100
Dec.	3	11	29	54	77	91	100	100
Jan. 1959	3	9	23	49	66	83	86	100

TABLE 24

Cumulative Per Cent Distribution of α-Cholesterol in Per Cent of Total Cholesterol in Policemen and Convicts

α-Cholesterol Per Cent	≦ 15	≦ 20	≦ 25	≦ 30	≦ 35	≦ 35.1 or over
Policemen						
Feb. 1958	13	38	69	82	93	100
March	16	38	64	89	100	100
April	7	29	58	80	89	100
May	9	29	58	84	98	100
June	7	27	53	80	98	100
July	9	33	53	82	100	100
Aug.	13	33	60	82	100	100
Sept.	16	40	67	87	100	100
Oct.	16	38	60	87	98	100
Nov.	20	36	60	89	98	100
Dec.	13	38	58	84	98	100
Jan. 1959	9	33	56	82	98	100
Convicts						
Feb. 1958	6	26	51	77	97	100
March	3	31	57	94	100	100
April	—	14	49	71	94	100
May	6	26	54	80	97	100
June	3	26	49	74	97	100
July	11	31	60	83	91	100
Aug.	6	23	54	91	97	100
Sept.	9	37	69	94	97	100
Oct.	3	37	63	94	97	100
Nov.	9	46	77	94	97	100
Dec.	11	43	74	94	97	100
Jan. 1959	14	37	77	97	97	100